Motorship

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ARTICLES on design, construction and operation of oil-engines and motorships by the world's foremost writers on marine engineering.

Motorship

ILLUSTRATIONS of the newest designs in international merchant motorship and Diesel-engine construction and auxiliary equipment.

Vol. XI February, 1926 No. 2

Asturias Completed for the R.M.S.P.

New Motorliner, 22,500 Tons Gross and with Double-Acting Engines of 15,000 s.hp. Is Amongst Largest Ships of the World

ASTURIAS the largest and most powerful motorliner yet completed ran trials last month and was delivered to her owners, the Royal Mail Steam Packet Co. She is 5000 gross tons bigger than any motorliner yet in service, bigger than the ss. MALOLO which Cramp's are now building for the Matson Navigation Co., within 1000 gross tons of the ss. GEORGE WASHINGTON and about the fifteenth largest vessel of any kind in the world.

Intended for the R.M.S.P. service between England and South America the ASTURIAS will set a new record for comfort and luxury much in advance of anything yet seen in the South Atlantic. She will later be joined in that service by the motorliner ALCANTARA which is being built for the same company. During the course of this year they will meet in South American ports, two palatial motorliners of about the same size which the Cosulich Line is building for the service between the Mediterranean and South America. These vessels will be a wonderful advertisement in South America for British and Italian shipping respectively.

From these considerations one may gather the importance of the ASTURIAS which Harland & Wolff completed last month and sent on successful trials. In appearance she presents a certain novelty as the picture of her on this page shows.

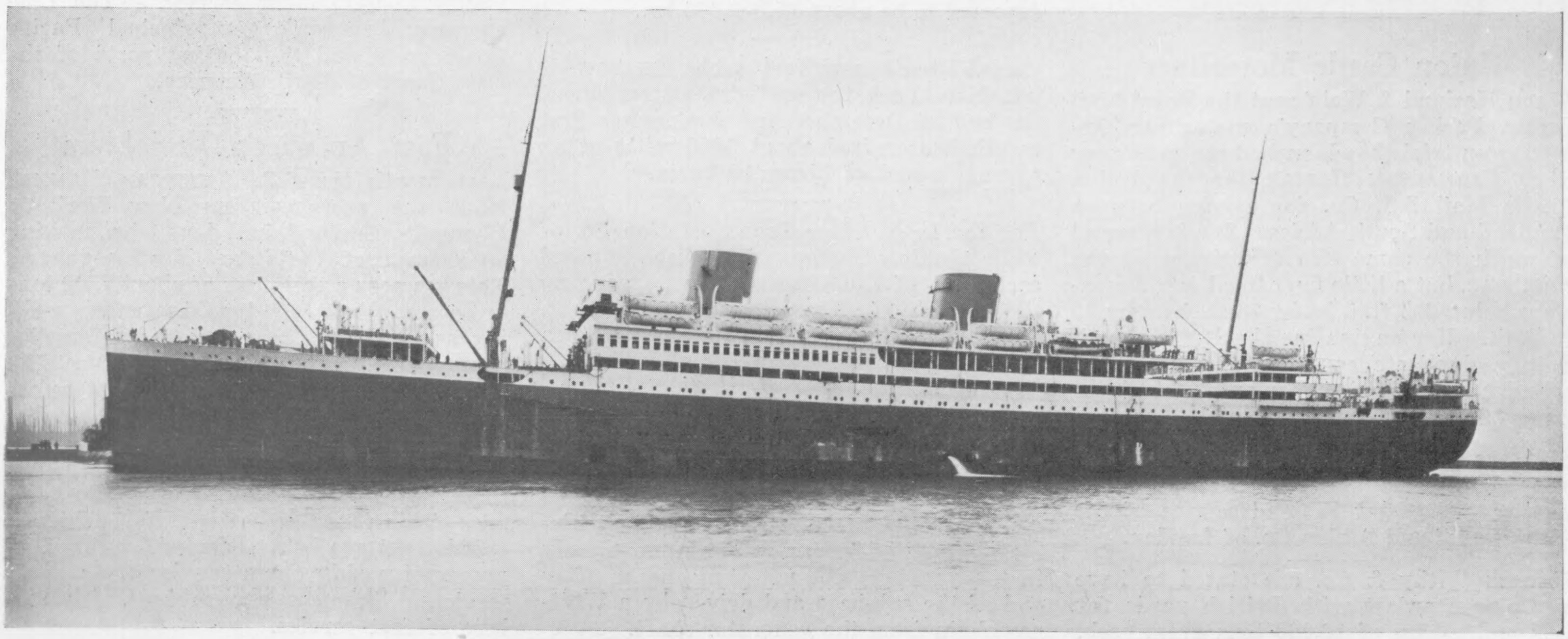
Characteristics of m.s. Asturias

Length, o.a.	655 ft. 8 in.
Breadth, molded	78 ft. 0 in.
Depth, molded to upper deck	45 ft. 0 in.
Gross register	22,500 tons
Power (2 engines)	20,000 i.hp.
Sea speed	17 knots

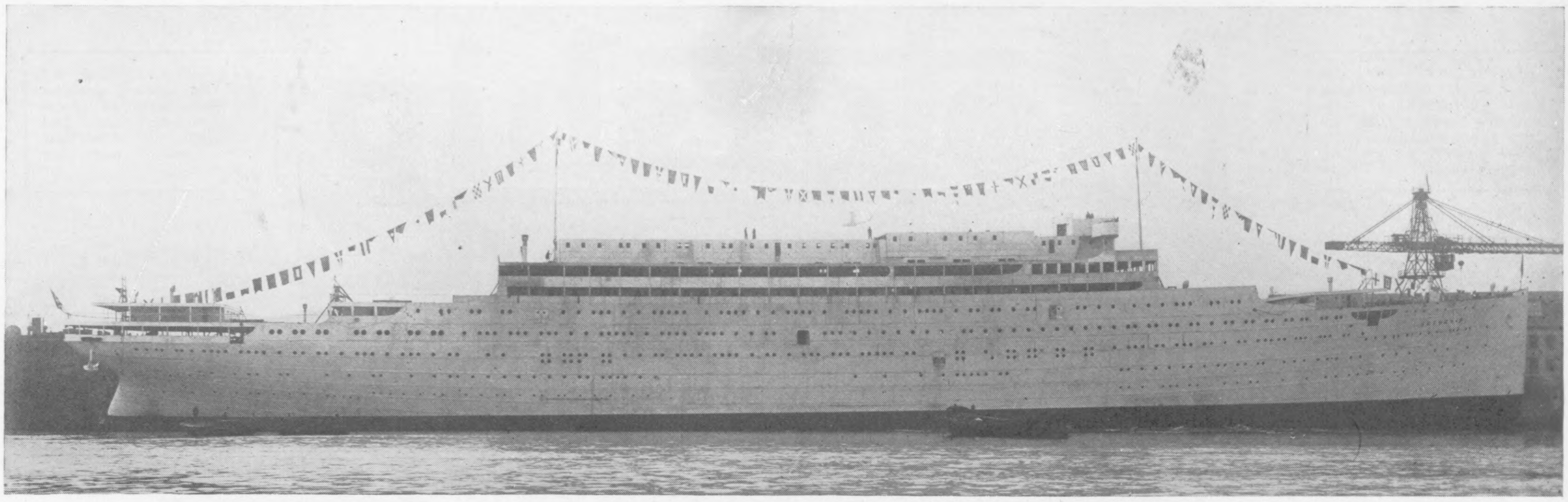
Her propelling machinery consists of two eight-cylinder Harland & Wolff-B.&W. type 4-cycle double-acting engines of 10,000 i.hp. each with direct connected compressors. The cylinders are 33.97 in. diameter and the piston stroke is 59.05 in., these dimensions being the same as those of the GRIPSHOLM'S engines. The ASTURIAS' machinery, however, is more powerful, each set having eight cylinders compared with the six cylinders of the GRIPSHOLM engines. Not all of the power developed by the extra two cylinders will be available for propulsion, because, in contrast with the practice shown in the GRIPSHOLM, Harland & Wolff have connected the main compressors directly to the main engines. The shaft hp. is therefore, probably about 7500 s.hp. compared with about 6750 s.hp. on each of the GRIPSHOLM shafts.

In addition to the two big main engines the ASTURIAS has four auxiliary Diesel engines of about 550 b.hp. each, direct connected to 400 kw. electric generators. These compare with the GRIPSHOLM installation of three compressor engines, each of 750 b.hp., and three 500 b.hp. engines direct connected with 330 kw. generators. Both vessels also possess an emergency lighting set on the boat deck. Both ships, therefore, have about the same aggregate engine power, namely about 17,200 b.hp. in all. In the case of the ASTURIAS there is approximately 1500 s.hp. more available for propulsion.

Another interesting contrast between the ASTURIAS and the GRIPSHOLM is afforded by a comparison of the heating systems. Whereas on the GRIPSHOLM steam is furnished by two oil-fired boilers for heating the forward living spaces and for heating the air supply to the thermo tanks for the passenger accommodation, on the ASTURIAS no steam at all is used for heating, electric radiators being used throughout. It must be borne in mind, however, that the GRIPSHOLM has to face the severe cold sometimes encountered in New York and in Gothenburg, besides the cold of the winter North Atlantic whereas the ASTURIAS will never experience colder weather than that of the mild winters in England and in the River Plate.



Profile view of the Royal Mail Steam Packet Co.'s new motorliner Asturias, one of the biggest vessels in the world



Hull of the Italian motorliner Saturnia, 23,500 tons gross, launched six months after the keel was laid, to be commissioned in June

On the ASTURIAS the problem of ventilation is more acute because she traverses the tropics every passage. Her thermo tank system, therefore, is provided with means for delivering cold air to the passenger accommodation when needed, as well as warm air when required. On the GRIPSHOLM the thermo tank system delivers only warm air or air direct from the atmosphere. Steam, of course, is required for cooking on these big ships and the ASTURIAS is provided with two small oil fired vertical boilers for that purpose, but there is no other use of steam on this ship, except that it can be utilized to drive a small emergency air compressor to replenish the air bottles in the engine room after a survey.

ASTURIAS has accommodation for about 1800 pasengers and crew. The decoration of the public rooms in the 1st class equals that of any of the North Atlantic liners. There are 17 public rooms throughout the ship, including the 1st class dining room, two decks in height and measuring 94 ft. in length by 74 ft. in breadth, social halls, lounge, winter garden, smokerooms, Pompeiian swimming pool, children's play room.

Seven electric elevators are installed, and there is an electric laundry for the convenience of passengers. All cooking will be done on electric ranges, the baking ovens will be electrically heated, all deck gear is electrically operated and, indeed, electricity is used for every purpose throughout.

Union Castle Motorliner

When Harland & Wolff sent the Royal Mail Steam Packet Company's motorliner ASTURIAS on trial they launched the passenger liner CARNARVON CASTLE for the Union Castle Mail S.S. Co. for service between England and South Africa. She is a vessel of much the same size and power as the ASTURIAS, but a little finer lined, her dimensions being 655 ft. 9 in. by 73 ft. 0 in. by 45 ft. 6 in. Her engine installation is practically a duplicate consisting of two eight cylinder double-acting Harland—B.&W. engines of about 15,000 s.hp. total.

Bids are being taken in Great Britain on two 20,000 tons motorships of 17 knots speed for the New Zealand service of the Shaw, Savill and Albion Co. of London.

Furness Withy & Co. are stated to have just placed orders with British yards for four motorships of 10,000 tons gross each.

Big Italian Motorliner

SATURNIA, the big Cosulich motor liner launched last December, will not be used in the New York service, but in the de luxe service between Italy and South America. She is expected to show a speed of nearly 20 knots and will be scheduled to make the run from Naples to Rio de Janeiro in 10 days and to Buenos Aires in 13 days. It is likely that she will be delivered next June and possibly her sister ship, the m.s. URANIA, the keel of which was laid only on Dec. 29 last, will be launched in April and delivered in Oct. or Nov. Both these vessels will have a gross register of 23,500 tons, according to latest reports. They have previously been reported with a slightly higher gross tonnage. The two main engines, which will be of the Burmeister & Wain double-acting type built by the Stabilimento Tecnico Triestino, will develop an aggregate of 18,000 s.hp.

For assistance in the building of a sister ship to the GRIPSHOLM the Swedish American Line has applied to the Swedish government for a loan of 8,000,000 kr. ($2,-144,000) from the special shipbuilding loan fund. In our issue of December 1925 we reported that the Swedish government had already agreed to lend a sum of 5,000,000 kr. ($1,340,000). The cost of building a duplicate of the GRIPSHOLM in Sweden is reported to be about 15,000,000 kr..

Carl Fisher's new fast yacht SHADOW K left New York for southern waters about the end of December and during her first month has cruised about 3000 miles at an average speed of about 16 knots.

For the L. B. Shaw Transportation Co. of Philadelphia, Chapman & Fisher, naval architects of the same city, are arranging the conversion of a twin-screw tug, 90 ft. long by 23 ft. beam by 12 ft. depth, to a single-screw boat with a Diesel engine.

MAMIE O, Mr. Oakman's 120 ft. Diesel-engined yacht, is having a small Diesel auxiliary set installed, composed of a 3-cylinder Hill, direct connected to a 12 kw. Diehl d.c. generator, and the Nelseco 2-stage air-compressor and Viking rotary pump already in the yacht will be mounted on the after end of the sub-base and driven by a Whitney chain from the generator shaft.

Delay in S. B. Conversions

"Work on the first unit of the 14 vessels selected for Dieselization is delayed," stated Capt. Gatewood, manager of the Maintenance & Repair Department of the Fleet Corp. in New York and also in charge of the Shipping Board's Diesel program. "I fear the government will have to grant an extension of time to the engine builders of the United States, who have met with many difficulties in constructing the engines. The government is not impatient with the builders, as we realize that they have many difficult problems to solve, and we want to aid them in every way."

Administrative changes relating to the merchant marine as recommended by the National Merchant Marine Conference held in Washington under the auspices of the Chamber of Commerce of the United States last November are provided for in a bill introduced in the House of Representatives last month by Representative R. L. Bacon of New York.

Last month the Pacific Argentine Brazil Line was sold to the McCormick Steamship Co. of San Francisco for five years guaranteed operation. Six steamers of approximately 8800 d.w.c. each were transferred at a price of about $49,500 per ship. This is the first sale the Board has made of a Pacific Coast freight service. The Line operates between the principal Pacific Coast ports and the leading ports of the East Coast of South America.

Fast American Freighters

Last month the S.S. AMERICAN BANKER made the passage from New York to Plymouth, England, in 8 days 1 hr., making an average of 15¾ knots for the voyage. This vesesl is a freighter of about 7500 tons gross and about 7000 tons d.w. and is making as good time as many of the smaller passenger liners on the North Atlantic. She is one of five Shipping Board steamers operated by J. H. Winchester & Co. on the New York-London service and, on account of their speed, these have lately been able to get shipments of mail from the Post Office. This is an indication of the higher speeds that are being adopted by the most progressive ship operators for their cargo services. Shippers always have felt the lure of fast service.

Gripsholm's Successful Performances

Swedish American Line's Flagship Continues Her Excellent Demonstration in the Transatlantic Service

GRIPSHOLM returned to New York the middle of last month on her second voyage. She had sailed from here on Dec. 10 and arrived at Gothenburg on Dec. 18. Sailing from Gothenburg again on Jan. 5, she reached New York on Jan. 14, after a very rough passage. On Jan. 20, she sailed from New York again for her home port.

To provide for a close inspection of the engines after her first round voyage, her schedule gave her 18 days at Gothenburg. This, of course, is an exceptional interval between arrival and sailing. She will normally turn round in the same period as the s.s STOCKHOLM and the s.s. DROTTNINGHOLM of the same Line. She is not in the schedule to make any March sailing, it being understood that after her third round voyage she is to make trials with new propellers, those at present fitted being too large to permit the engine to turn up to full rated speed.

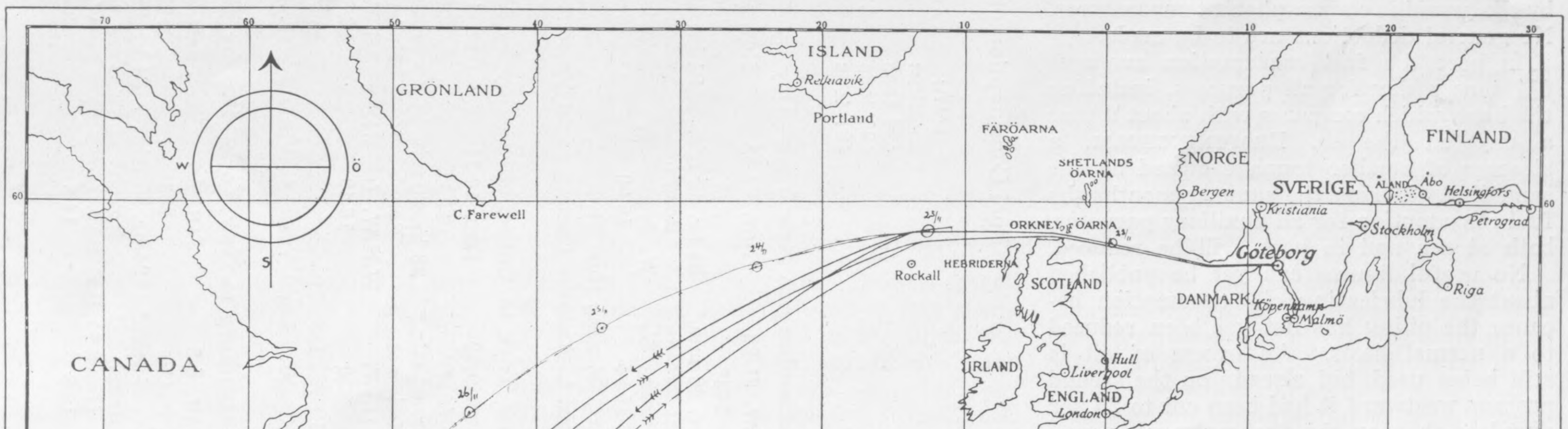
A summary of the maiden transatlantic passage from Gothenburg to New York was given in our December issue. To this summary can now be added similar extracts from the logs of her first homeward passage and of her second westward passage to New York. On her homeward run in December she was favored with reasonably good winter weather and made more than a ½ knot better average speed than she had logged on the westward run. Fuel levers were set in the same notches as on her first transatlantic passage, and the improvement in speed therefore was due entirely to better weather.

After she reached Gothenburg the main engines were inspected pretty thoroughly and the examination proved entirely satisfactory. Three pistons were drawn with their piston rods to permit the cylinders, pistons, piston rings and piston rod stuffing boxes to be looked at. The pistons showed the original machine tool marks quite plainly; the piston rings were entirely free and exhibited no tendency to become stuck; the piston rods were without a scratch and the stuffing boxes quite clean. In the lower combustion chambers the only trace of dirt was a slight grayish dust, and they were cleaner than the upper combustion chambers. A good fuel is, of course, being used, no chances being taken with any fuel containing elements likely to increase wear on the moving parts.

One may now accept as a demonstrated fact that the Burmeister & Wain double-acting engine possesses no defects to condemn it at the beginning of its career and that it promises results not inferior in any way to those obtained by the single-acting engine of the same make. It is said that the late Dan Broström, when he ordered these engines, contemplated that if any trouble should manifest itself in the bottom ends of the cylinders the lower covers would be removed and the engines converted to a single-acting type, without the loss to the ship of more than a couple of knots speed. It is evident today that recourse will never have to be made to that stringent expedient which Broström remotely contemplated.

GRIPSHOLM sailed from Gothenburg on her second voyage on Jan. 5 and ran almost immediately into bad weather. On the afternoon of Jan. 6 she ran into a S. E. gale of force 9, which blew for two days, gradually veering from S. E. to S. W., and the high seas reduced the speed. On Jan. 8 the wind dropped considerably and the sea began to moderate, enabling a better speed to be maintained for the next 24 hours. Then the wind came up strongly out of the S. and S. E. and increased to force 11. The barometer fell lower and lower until at 5 p. m. (Jan. 9) it read 27.54 in., lower than anybody aboard had ever seen it. On the bridge there followed an hour of suspense, until at 6 p. m. the wind dropped to force 3, veered round to W. and did nothing worse than commence to blow strongly again until it reached a maximum of force 11 at 4 a. m. on Jan. 10, with the glass then rising fast and the sea running very high. (Force 11 is the next to the highest reading on the Beaufort scale.) GRIPSHOLM apparently went right through the center of the storm.

For the 24 hours previous to noon on Jan. 10 she maintained an average of only 13 knots. The wind then began to decrease, leaving a high swell which held down the speed, but the last three days into New York were marked by a moderate sea and moderate winds. In the last 24 hours up to the Ambrose Light Vessel a speed of 17.2 knots was maintained, the best the GRIPSHOLM has so far logged for a whole day during any passage.



Track of the maiden transatlantic passage of the motorliner Gripsholm. The arrows indicate spring and summer ice tracks

Chief Engineer Thorell related in New York that during the rough weather of Jan. 9 he received an order to reduce speed for several hours. The governing proved superior to that of single-acting engines. Single-acting Diesel engines govern, of course, much better than steam engines, and this gives an indirect line on the manner in which the double-acting Diesel engines respond to the governor. Mr. Thorell is of the opinion that the governing is helped by the heavy counterweights fitted to all cranks. They tend to prevent sudden changes in speed. The Aspinall governors cut out all fuel pumps except those of No. 6 cylinders.

Power and fuel consumption both vary according to the weather conditions. Against a strong head wind and a heavy swell the vessel of course meets with greater resistance, and the engine revolutions drop correspondingly. Reckoned over the entire duration of the passage the engine speed averages about 113 r.p.m. In the same general manner the power may be stated to average 15,500 i.hp.

The best measure of the average maintained power of the engines during the passage is the fuel consumption. On the maiden run to New York the main engines burned 426 tons. On the first homeward passage the fuel consumption was reduced to 420 tons on account of better weather conditions, and during the third transatlantic passage the figure was raised to 437 tons on account of heavier weather.

Details of the fuel consumption of the main engines, auxiliary engines, heating boilers and galley are set out in a table on this page. The fluctuations in the fuel consumptions of the auxiliary engines are due largely to sky conditions, extra hours of lighting for the whole ship making a big difference in the quantity of fuel burned. In a similar manner the consumption of fuel in the heating boilers is largely affected by the prevailing atmospheric temperatures. No general deductions are to be made.

In port the fuel consumption averages 6¼ tons a day for all purposes, including the heat, which compares with about 9 tons a day on the ss. DROTTNINGHOLM, a steamer of smaller tonnage owned by the same line. During the summer months the fuel consumption for all auxiliary purposes, both at sea and in port, will be reduced.

No useful figures can yet be published about the lubricating oil consumption because the oiling has not yet been reduced to a normal basis. An excess of oil is still being used, but already on the second passage westward it had been cut to 25 per cent less than on the first passage.

While the vessel was in New York the routine inspection was continued and again it proved entirely satisfactory. When this inspection was completed both the main engines were turned over, and we had the opportunity of witnessing them start from cold. The performance was impressive. Both engines were run up to about 45 r.p.m. on air and then given fuel, which they commenced to burn immediately without any valve popping and without missing fire. Single-acting engines starting from cold at the same engine room temperature and with the same temperature of water intake would probably have required air two or three times to start firing at the same reduced revolutions, and almost certainly would have been popping.

Fuel Consumption of Motorliner Gripsholm—First Three Passages

	Per Passage				Per Day			
	Main Engines	Auxiliary Engines	Heating & Galley	Total per Passage	Main Engines	Auxiliary Engines	Heating & Galley	Total per Day
Voyage 1 Westward	426 tons	93.7 tons	63.3 tons	583 tons	47.6 tons	10.45 tons	7.1 tons	65.1 tons
Voyage 1 Eastward	420 tons	81.9 tons	72.1 tons	574 tons	48.3 tons	9.4 tons	8.3 tons	66 tons
Voyage 2 Westward	437 tons	85.0 tons	60.0 tons	582 tons	45.5 tons	8.9 tons	6.2 tons	60.6 tons

Gothenburg to New York—Day by Day Runs of the Motorliner Gripsholm—Voyage 1 Westward

	Nov. 21-22	Nov. 22-23	Nov. 23-24	Nov. 24-25	Nov. 25-26	Nov. 26-27	Nov. 27-28	Nov. 28-29	Nov. 29-30
Distance—sea miles	364*	395	408	391	402	376	425	387	248**
Hours—noon to noon	22 hr. 48 min.*	24 hr. 48 min.	24 hr. 48 min.	24 hr. 48 min.	24 hr. 36 min.	24 hr. 34 min.	24 hr. 28 min.	24 hr. 36 min.	16 hr. 30 min.**
Sea	Moderate	Rough	Moderate	High swell	High swell	High cross sea	Smooth	Rough	Moderate
Wind	Strong W.	W. decreasing	Variable	Strong W.	Strong S.E.	Variable	Light variable	Strong W.	Strong N.W.
Speed—knots	15.95	15.90	16.45	15.75	16.35	15.30	17.35	15.70	15.00

* From Vinga Light (14 sea miles), passed at 1.56 p.m., Nov. 21. ** To Ambrose Channel Light Vessel, passed at 4.05 a.m., Nov. 30.

Average speed from Vinga Light to Ambrose Channel Light Vessel .... 16 knots.

New York to Gothenburg—Day by Day Runs of the Motorliner Gripsholm—Voyage 1 Eastward

	Dec. 9-10	Dec. 10-11	Dec. 11-22	Dec. 12-13	Dec. 13-14	Dec. 14-15	Dec. 15.16	Dec. 16-17	Dec. 17-18
Distance—sea miles	325*	386	396	395	381	395	393	381	327**
Hours—noon to noon	20 hr. 04 min.*	23 hr. 30 min.	23 hr. 28 min.	23 hr. 28 min.	23 hr. 20 min.	23 hr. 20 min.	23 hr. 12 min.	23 hr. 09 min.	20 hr. 03 min.**
Sea	Moderate	Rough	Moderate	Moderate	Moderate	Smooth	Smooth	Moderate	Moderate
Wind	N. W.	W.N.W. (snow)	S. W.	Variable	S. E.	S. E.	Variable	W.	N. W.
Speed—knots	16.20	16.40	16.87	16.83	16.35	16.93	16.95	16.42	16.30

* From Ambrose Channel L. V., passed at 3.16 p.m., Dec. 10. ** To Vinga Light, passed at 8.51 a.m., Dec. 18.

Average speed from Ambrose Channel Light Vessel to Vinga Light .... 16.6 knots.

Gothenburg to New York—Day by Day Runs of the Motorliner Gripsholm—Voyage 2 Westward

	Jan. 5-6	Jan. 6-7	Jan. 7-8	Jan. 8-9	Jan. 9-10	Jan. 10-11	Jan. 11-12	Jan. 12-13	Jan. 13-14
Distance—sea miles	394*	353	329	382	319	375	396	411	422**
Hours—noon to noon	23 hr. 27 min.*	24 hr. 55 min.	24 hr. 38 min.	24 hr. 38 min.	24 hr. 34 min.	24 hr. 30 min.	24 hr. 32 min.	24 hr. 34 min.	24 hr. 33 min.**
Sea	Rough	Rough	Very rough	Very rough	High swell	High swell	Moderate	Smooth	Moderate
Wind	S.E. (force 9)	S.E.-S.W. (force 9)	W.	S-SE (force 11)	W. variable	W. decreasing	W. moderating	——	W.
Speed—knots	16.8	14.3	13.4	15.5	13.0	15.3	16.2	16.7	17.2

* From Vinga Light, passed at 1.40 p.m., Jan. 5. **To noon, before reaching Ambrose Channel Light Vessel, (passed at 12.42 p.m.).

Average speed from Vinga Light to Ambrose Channel Light Vessel .... 15.3 knots.

Motor Tankers of Standard Oil Co. (N. J.)

Schedule of Development in Last 3 Years Has Included 16 New Ships and 8 Conversions

By W. F. Dunning*

WHILE a saving of approximately two-thirds in fuel consumption and increased carrying capacity proportionate to the lesser bunkers required are recognized advantages from the operation of Diesel-propelled vessels as compared to those operated by steam plants, there are many uncertainties that surround the final determination, involving as it does a large capital outlay, to scrap a steam plant and convert to Diesel operation.

Foremost is the uncertainty that attends any decision for which there is no available actual experience over a period of time to serve as a precedent. While the Diesel engine has been used for marine propulsion for a number of years, it has been subject to such rapid development within the last few years that there are practically no figures available covering operation of particular engines over a period of years from which actual results may be judged. This is especially important in the item of repairs and replacements, which might conceivably run to such proportions as to largely offset the seeming advantages from Diesel operation.

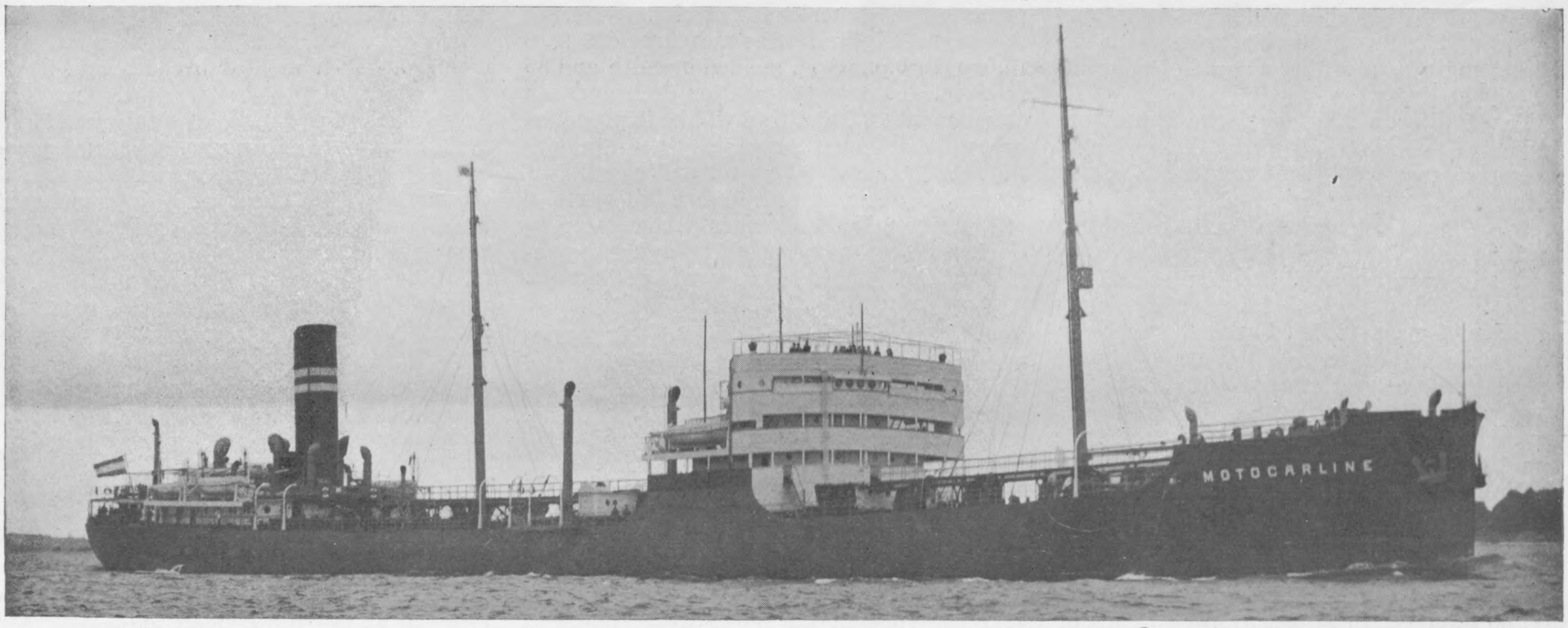
There is also the question of increasing costs for fuel, and in the last analysis the ultimate success of the Diesel engine for marine use largely depends upon the ability to use in this engine the lower grades and cheaper fuel oils. To date no Diesel engine has burned heavy Mexican fuel, such as is used under boilers today, continuously over a long period of time. It has still to be demonstrated that Diesel engines can be constructed of such design and materials as to withstand the effects from burning low-grade oils, or whether the renewals and replacements resulting therefrom will offset the lower costs for the heavy fuels.

In view of the rapid development now in progress, a further risk is the possibility that the type of engines now selected may become obsolete in a comparatively short space of time.

As a large producer and marketer of oil, however, the Standard Oil Co. (N. J.) has considered it should properly take its place as a pioneer by the adoption of Diesel propulsion for marine use. Its first Diesel ships, the HAGEN, LOKI, WOTAN and ZOPPOT, were constructed in 1913 during the early stages of Diesel development. This development was, of course, brought to a standstill for commercial purposes during the war. Diesel propulsion could not be considered for the extensive construction program undertaken in American yards from 1916 to 1921, because there were at that time few, if any, large Diesel engines for marine use manufactured in this country. In 1923, 1924 and 1925, when the tonnage requirements of our foreign subsidiaries necessitated new construction, Diesel propulsion was selected throughout.

As a result, contracts were placed abroad for a total of 16 Diesel tankers, aggregating approximately 190,000 deadweight tons. On the only construction undertaken for this company in the United States within the last few years, Diesel engine propulsion was used for the lighter, CHARLIE WHITE, now in use in New York Harbor, and for the 11,000 barrel tank barge J. H. SENIOR, operated in the Chesapeake Bay service, Diesel-electric drive was selected.

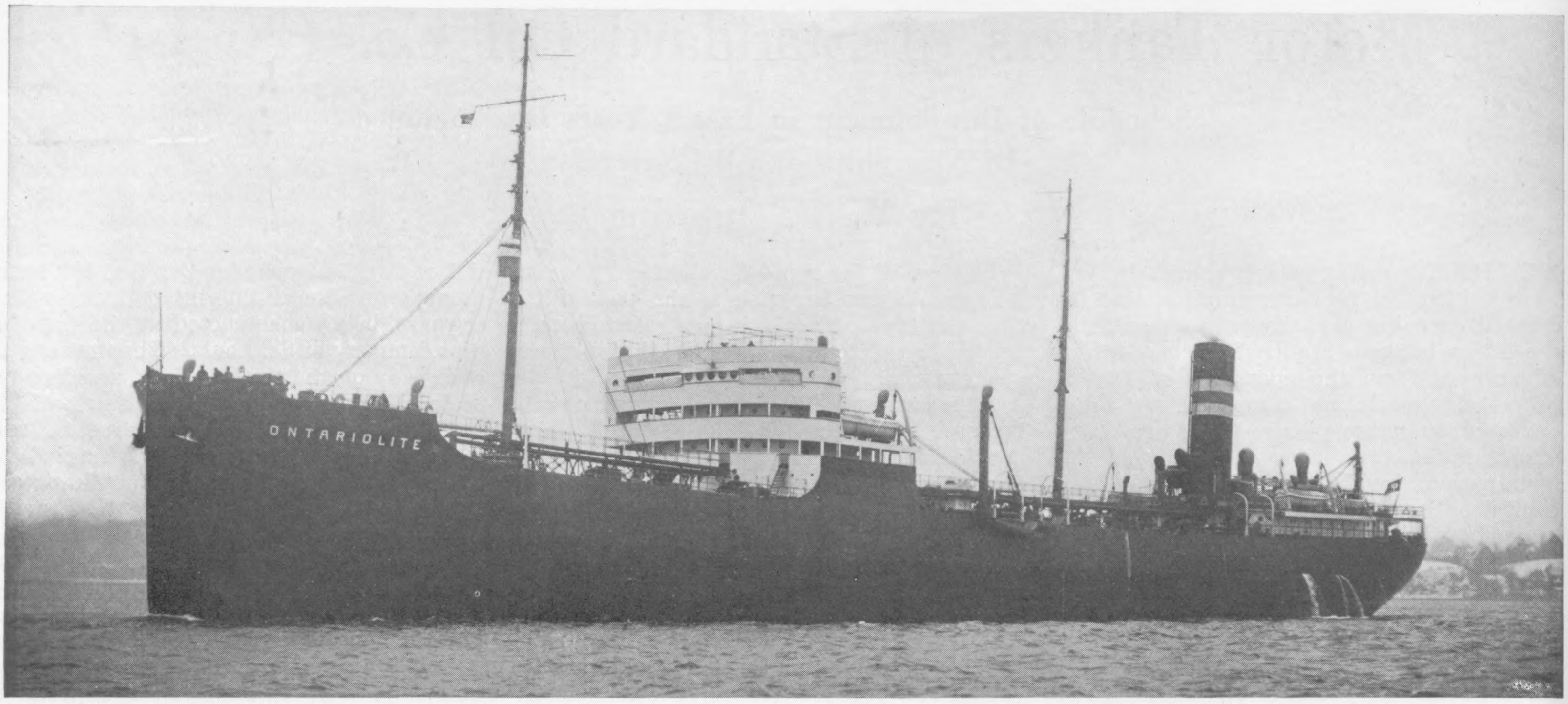
In addition to this extensive adoption of Diesel propulsion for new construction, in the latter part of 1924 this company placed contracts for conversion of two of its 15,000 ton steam vessels, the E. T. BEDFORD and J. A. MOFFETT, JR., to Diesel propulsion, at a cost of over a million dollars. The installation for the E. T. BEDFORD will consist of two four-cylinder 2-cycle 1500 brake horsepower Busch-Sulzer engines, which are now being constructed at the plant of that company at St. Louis. The first engine is already on the testing block, and it is expected that they will both be completed the early part of this year. The actual conversion and installation will be carried out at the yard of the Federal Shipbuilding and Dry Dock Company at Kearny, N. J., within approximately ninety days after the engines are finished. The J. A. MOFFETT, JR., is to be equipped with two four-cylinder 2-cycle 1500 brake horsepower Hamilton M. A. N. engines, which are now being constructed by the Hooven-Owens-Rentschler Company, at Hamilton, Ohio. It is promised that they will be completed by June of this year, the conversion and installation to take place at the Tietjen and Lang Dry Dock Company's yard, at Hoboken, N. J., so that this vessel should be re-engined early in the fall of 1926. These vessels will have a designed speed of 11 knots.



Motocarline, a motor tanker of about 12,000 tons d.w.c., owned by the Belgian subsidiary of the Standard Oil Co. (N. J.)

In addition to conversion of these American vessels, certain of our foreign subsidiaries have arranged to convert some of their ships from steam to Diesel propulsion. The Imperial Oil, Limited, of Canada, has recently converted the MS. TRONTOLITE, 9,000 deadweight tons. In lieu of the steam plant, this vessel has been equipped with one six-cylinder 2-cycle 2150 brake horsepower Krupp Diesel engine, designed speed of vessel approximately 10½ knots, which work was completed by Krupp Germania-werft, at Kiel-Gaarden, Germany, in May of this year. Contract has also been placed for conversion of the ss. G. HARRISON SMITH at the Bremen Vulkan Yard, Germany. This vessel, with a carrying capacity of 20,495 deadweight tons, is one of the largest combination oil and ore carriers in the world. Upon conversion about the

* In *The Lamp*, the monthly house magazine of the Standard Oil Co.



Motortankship Ontariolite, about 12,000 tons d.w.c., is owned and operated by the Canadian subsidiary of the Standard Oil Co. (N. J.)

end of 1926 this ship will have two four-cylinder 2-cycle 2150 brake horsepower Diesel engines, affording a speed of approximately 11 knots.

The Baltische Amerikanische Petroleum Import Gesellschaft, Danzig, has already converted two 9,000 deadweight ton sister ships, the JOSIAH MACY and S. V. HARKNESS. These conversions were completed in June and August of this year by Krupp Germaniawerft, at Kiel-Gaarden, Germany each installation consisting of one six-cylinder 2-cycle 2150 brake horsepower Krupp Diesel engine, to give a designed speed of approximately 10½ knots. Further contracts have recently been placed by the Danzig company for conversion of two 14,000 ton vessels, the ss. BALTIC and ss. VISTULA. This work will be undertaken by A. G. Weser, Germany, which it is estimated will be completed about August, 1926, each installation to consist of two four-cylinder 2-cycle 1550 brake horsepower Krupp engines, to afford a speed of about 11 knots.

While necessarily this conversion program assures a proper return upon the capital outlay involved, the fact remains that it constitutes a practical and far-reaching contribution to the development of the Diesel engine. The solution of the many problems surrounding the selection of proper types and weights of engines to use, their installation to the best advantage, the training of personnel for their operation, experimentation being conducted in burning different grades of fuel oil, adoption of the best suited lubricants and overcoming the problems of repairs and renewals, will all afford genuine experience which will hasten the day when the use of the Diesel engine for marine propulsion will well be tried out and free from its present risks and difficulties. Each one of these ships is, in fact, a floating laboratory where experiments are being made which will be of practical benefit to the shipping industry as a whole.

MOTOCARLINE, a sister vessel to the PERSEPHONE, was completed by Krupp's. Her owners are American Petroleum Co., of Antwerp, Belgium. She measures 469 ft. 6 in. length b.p., 63 ft. molded breadth and 35 ft. 6 in. depth to the shelter deck and can carry about 12,000 tons d.w. She is propelled by two 4-cylinder 2-cycle engines developing 1450 s.hp. at 90 r.p.m. and capable of giving 1600 s.hp. maximum. Like so many of the other tankers recently completed in Germany she has been built for the expansion of the American oil trade in Europe.

The twin-screw motor tankship ONTARIOLITE was built and engined by Krupp's and is registered under the ownership of the Imperial Oil Company of Toronto, Canada. She is a sister vessel of the motortankships PERSEPHONE and MOTOCAROLINE, with a dead-weight capacity of about 12,000 tons, measuring 469 ft. 6 in. between perpendiculars, 63 ft. molded breadth and 35 ft. 6 in. depth to the shelter deck. For propulsion she has a pair of four-cylinder 2-cycle Krupp engines giving a normal power of 1450 s.hp. at 90 r.p.m. and capable of developing 1600 s.hp. at a higher speed. This is one of the large group of motor-vessels with which the Standard Oil Co. of N. J. is meeting foreign competition, the vessels being registered in the names of various subsidiaries and under the flags of the different countries in which those subsidiaries operate.

Three Motortankers for Gulf Refining Co.

Purchase of the motortanker under construction at the Camden yard of the American Brown Boveri Electric Corp., formerly the New York Shipbuilding Corp., was announced by the Gulf Refining Co. last month. This vessel, which will have a deadweight capacity of about 13,000 tons, will measure 460 ft. b.p., 65 ft. molded breadth and 24 ft. 8 in. molded depth to the tank deck, and her propelling machinery will consist of two A. B. B.-Werkspoor engines of 3000 s.hp. aggregate. The sales price was reported to have been between $1,400,000 and $1,500,000 or about $110 per d.w. ton. This vessel, which was fully described and illustrated in our November issue, is the second motortankship acquired recently by the Gulf Refining Co., the first having been the GULF OF VENEZUELA, about 9600 tons d.w.c., described in the same issue of MOTORSHIP. An order for a third vessel of about 15,000 tons gross will probably soon be placed by the same company, as announced in our last issue.

A 29-year old tank vessel of approximately 3000 tons d.w.c. is being overhauled by the Rotterdamsche Droogdok Mij and having her steam machinery taken out to be replaced by a 900 s.hp. Nobel engine built by Burgerhout's of Rotterdam. The installation of the Diesel power will be carried out at the Burgerhout shipyard. The vessel is owned by the Nobel oil interests. Built in 1896, this ship is 310 ft. registered length, 42 ft. breadth and 22.1 ft. depth, with a gross tonnage of 2849 tons. Her name is the BLACK SEA.

At the annual general meeting of the American Steamship Owners Association in New York, A. G. Smith was reelected president for a third term. The other officers elected for 1926 were: first vice-president, W. Newsome, vice-president of the United Fruit Co; and second vice-president, Paul H. Harwood, vice-president, Pan American Petroleum and Transport Co.

Three tankers are now on order at Palmer's Shipbuilding & Iron Company, Ltd., Jarrow, England, for an American oil company. Two tank vessels for the same company were delivered by this yard about a year ago.

Many of the motor tugs that were operating on the New York State Barge Canal last season have been sent to Florida to work during the winter.

Ford Motor Co's. Motorship East Indian

First Oceangoing Motorvessel of Ford Fleet Makes Better Than 14 Knots on Her River Trials

LAST month the motorship EAST INDIAN was completed at the Sun yard for the Ford Motor Co. of Detroit and sailed on its maiden passage to New Orleans. She has been equipped with two Sun-Doxford engines which drive her at a speed of over 14 knots.

This vessel was purchased by the Ford Motor Co. from the Shipping Board about a year ago and is 445 ft. registered length, 58 ft. breadth and 29 ft. depth of hold, measuring originally 8229 tons gross and with a deadweight capacity of 11,680 tons. She was built as a twin-screw vessel with triple expansion engines, and her conversion to motor power was facilitated by that machinery arrangement.

At the Sun yard she was thoroughly reconditioned, considerable changes being made in the accommodation for officers and crew, the quarters now being furnished and decorated in a manner superior to that of the staterooms of most of the coastwise passenger boats. The bridge has also received attention and has been completely equipped with the most modern aids to navigation. A Sperry gyro pilot has been installed, an R. C. A. radio compass added, and new engine room telegraphs of Sperry design were built for the vessel. A Rich fire detecting system has been installed.

In the engine room practically all that remains of the original steam installation is a Scotch boiler now transferred to a flat at the forward end. The new Sun-Doxford engines have four cylinders of 20¼ in. diameter and with a total piston stroke of 85 in. These engines at 95 r.p.m. develop a total of 5000 hp. They follow the usual Sun-Doxford construction with the opposed pistons. In the middle of each engine is a large scavenge air pump drawing its air through a pipe from the deck and delivering to the receiver at a pressure of about 2¾ lbs. This is in contrast with the electric turbo blowers used on the two Ford motorships on the Great Lakes.

Fresh water is used for cooling the cylinder jackets and pistons, this water being recooled by passage through a cooler containing about 1500 sq. ft. of cooling surface. Forced lubrication is used throughout and the oil recooled, a total of 1800 gal. of oil being kept constantly in circulation. Two De Laval centrifuges are installed for the purpose of purifying oil.

For electric power supply there are two 150 kw. generators of Crocker Wheeler build, direct-connected with 3-cylinder airless injection Worthington engines of the 2-cycle type, developing each 225 b.hp. at 275 r.p.m. These engines are self-contained with their own water pumps and lubrication systems. There are also two steam generator sets for use in port when the boiler is under steam and the main generator sets are shut down.

Steam has been retained for the deck machinery, the anchor windlass and cargo winches not having been converted for electric operation. A change, however, has been made in the steering engine, the steering gear now being operated by an electric hydraulic unit of the type built by the American Engineering Co.

At sea, therefore, no steam power will be used. The waste of fuel under the boiler will be confined to working days in port. Quick dispatch being one of the keynotes of Ford transportation, the extra cost of steam operation of the cargo handling appliances will be held down by the reduction of the operating time. The cost of converting the deck machinery to electric power may thus have seemed unwarranted when account was taken of the fact that the steam boiler and winches were already installed and therefore paid for.

There is much that is interesting in the EAST INDIAN, and we plan to give a more detailed description of the vessel at a later date. She is practically of the same size as the CALIFORNIAN and MISSOURIAN of the American-Hawaiian Line, and bigger than the WILLIAM PENN, the Shipping Board's most economical vessel.

East Indian, about 8200 tons gross, on the Delaware River prior to leaving on her maiden passage to New Orleans

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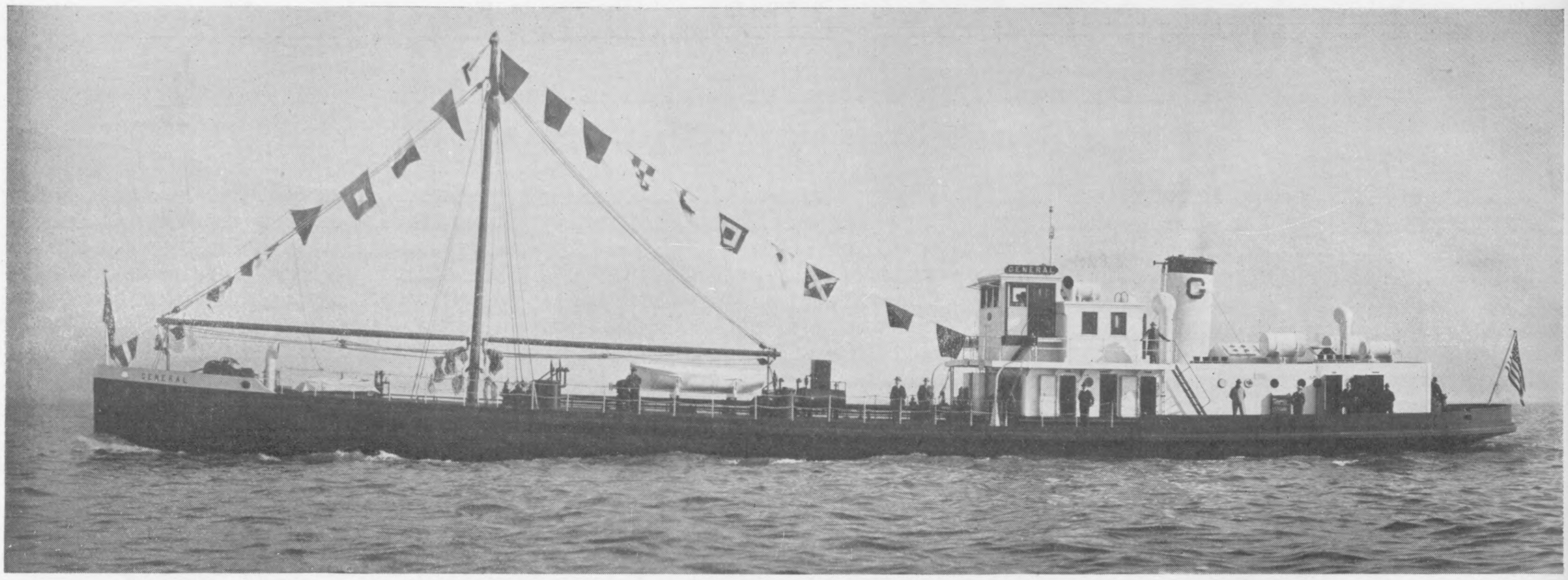
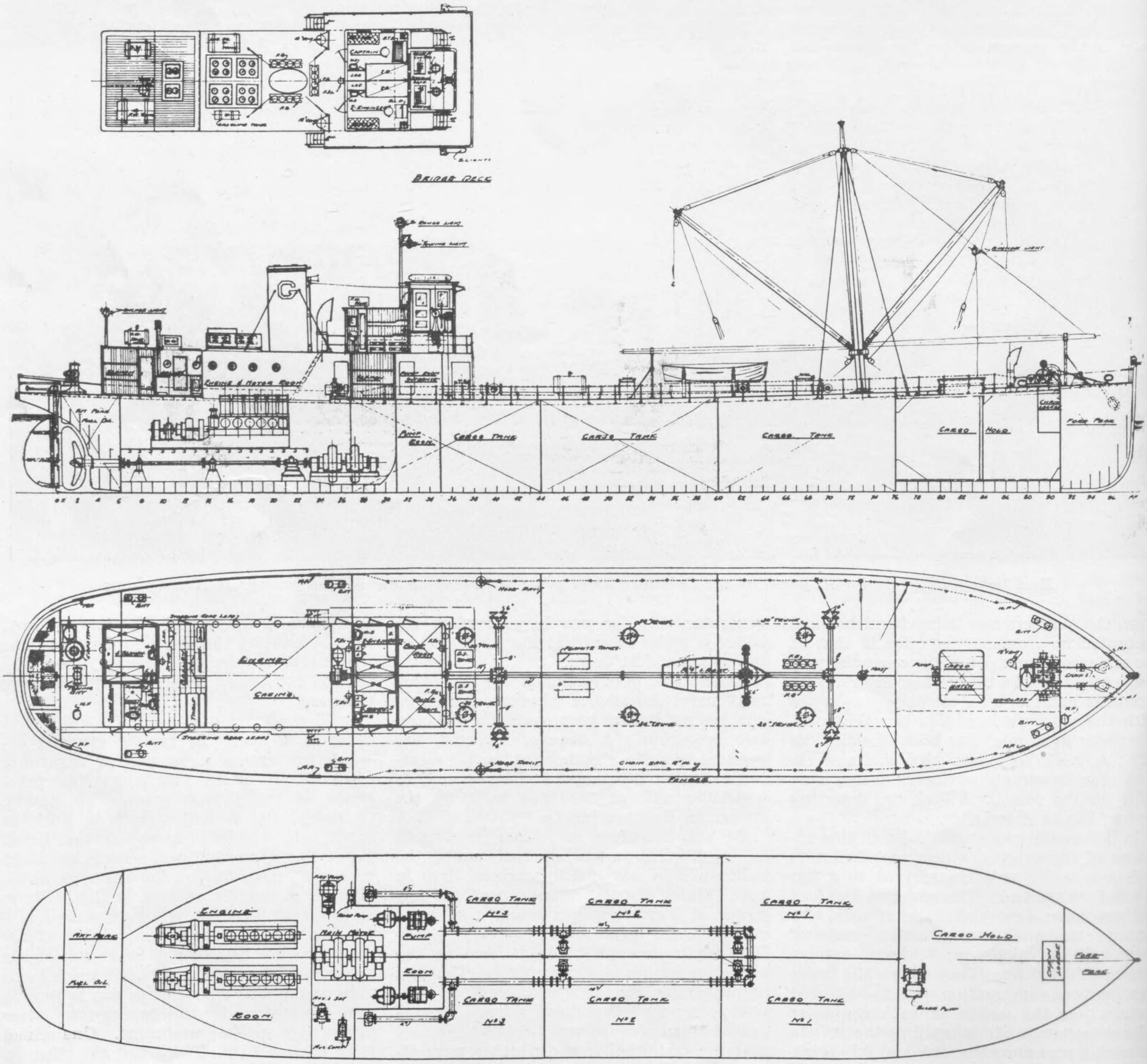
Last month a contract was signed between the Inland Waterways Corp. and private interests in Minneapolis and St. Paul providing for the extension of the government barge operations on the Mississippi River from St. Louis north to the Twin Cities. Under the terms of the contract, terminal facilities are to be built at once by the municipalities of St. Paul and Minneapolis and $500,000 worth of equipment, satisfactory to Brig. General T. Q. Ashburn, Chairman of the Inland Waterways Corp., is to be built by the private interests. The new barge service will operate under the title of the Upper Mississippi River Barge Company.

In order to meet the rapidly growing demand for authentic knowledge regarding the care, operation and underlying principles of the gyro-compass, The Sperry Gyroscope Co. of Brooklyn, New York, is conducting special schools on the Great Lakes this winter. These schools are fitted with equipment duplicating the type which is being so rapidly adopted in that district and over 40 of which will be installed during the winter. The great number of applications for enrollment in these schools has made it necessary to limit the attendance to captains whose ships are to receive gyro-compasses this winter and to other masters by special enrollment. One school is in Marine City, Mich., and the other in Cleveland, O.





General view, imboard profile, deck and hold plans of the San Francisco Bay tank barge General, 6000 bbl. capacity

Another Diesel Electric Oil Tank Barge

General Petroleum Corp. Commissions 6,000 bbl. Tanker for Service on San Francisco Bay

GENERAL, a Diesel electric barge for the General Petroleum Corporation's use in San Francisco harbor, has recently been completed. Her machinery installation is compact yet roomy and gives increased advantages in carrying capacity, maneuvering and operating economy as compared with other boats of 6000 bbl. capacity operating on the Pacific Coast.

Examples of rapid pilot house control were demonstrated by the ease of handling in the following tests made on the trial trip: the rudder was put hard to starboard and a complete circle made in 2 min. 55 sec.; from full speed ahead to full speed astern only 16 sec. were required, and the vessel actually moved astern in 1 min. 20 sec.

Characteristics of m.v. General

Length overall	176 ft. 6 in.
Length b. p.	170 ft. 0 in.
Breadth molded	32 ft. 0 in.
Depth molded	14 ft. 0 in.
Capacity	6000 bbl.
Draft—light .... (mean)	4 ft. 6 in.
Draft—loaded ...... (mean)	11 ft. 9 in.
Displacement—light	457 tons
Displacement—loaded	1372 tons
Power of main engines (2)	500 s.hp.
Rating of main generators (2)	290 kw.
Main propelling motor	350 s. hp.
Propeller diameter	7 ft. 0 in.
Propeller pitch	6 ft. 9 in.
Propeller revolutions	160 r.p.m.

Two main Westinghouse 250 volts d. c. generators, each rated 145 kw. at 275 r. p. m., are direct-connected to 250 hp. Atlas-Imperial engines, with six cylinders of 11½ in. diameter and 16 in. stroke. Each engine has the following direct-driven pumps:

1—3-plunger fuel injection pump.

1—fuel oil daily service pump.

1—lubricating oil circulating pump.

1—centrifugal cooling water circulating pump.

2—sump lubricating oil pumps, driven from each end of the camshaft.

1—single stage starting air compressor.

Westinghouse d. c. compound wound 20 kw., 125 volts exciters are attached to the main generators and being over capacity are able to furnish power for the ship's auxiliaries. Each generator and exciter are mounted on a heavy cast iron extension of the Diesel engine bedplate.

The main motor is a 350 s. hp. double armature Westinghouse motor operating at 160 r. p. m. on full power. Control is of the variable voltage type operated entirely from the pilot house, with an emergency motor control added near the gauge board in the engine room. A Kingsbury two-shoe, self-lubricated, self-cooled thrust shaft and steady bearing unit which permits the use of a very short thrust shaft, minimizing the fore and aft space, is used. Both engines are mounted on a platform raised above the propeller shaft, thus effecting a compact and accessible installation. The main motor is installed forward of the generator units on a platform below the engine floor plates.

The average results obtained on the trials were:

Trials of m.v. General

Main engine—port	274 r.p.m.
Main engine—starboard	280 r.p.m.
Main propelling motor	170 r.p.m.
Power—port engine	279 i.hp.=237 b.hp.
Power—starboard eng.	257 i.hp.=219 b.hp.
Power—main propelling motor	389 s.hp.
Average speed of vessel	8.35 knots
Slip of propeller	24.2 per cent
TEMPERATURES OF CIRCULATING WATER	
Starboard engine—In	52 deg. F.
Starboard engine—Out	70 deg. F.
Port engine—In	52 deg. F.
Port engine—Out	94 deg. F.
Circulating water press.	11 lb. per sq. in.

The Allan Cunningham steering unit, consisting of a power steering gear of the drum type arranged for wire rope and driven by a 5 hp. motor, is located on a flat at the forward end of the engine room. An auxiliary hand steering gear in the pilot house is so arranged that in the event of an accident, or if for any reason the power is shut off, one can pull a pin in the hand steering gear and proceed to steer by hand irrespective of the rudder position. This feature is advantageous for a boat of this class which must maneuver considerably and is very often called upon to work in tight places. The anchor windlass is also of the Allan Cunningham type driven by a 10 hp. Westinghouse motor, fitted with a solenoid holding drum, and a spring loaded friction clutch is provided to prevent excessive strains breaking the gearing. An Allan Cunningham self-contained capstan located aft is also operated by a 10 hp. motor.

Two starting air tanks are installed in the engine room to furnish air at about 150 lb. pressure. A combined gas engine and single stage compressor unit supply starting air in emergencies. Each main engine is fitted with a single stage air compressor. Thus three compressors are available for furnishing starting air. A whistle tank is provided with compressed air at 60 lb. pressure through a reducing valve from the starting air tanks.

Two 1000 bbl. per hr. Northern rotary pumps are located in the pump room and driven by 60 hp. motors in the engine room. The shafts pass through stuffing boxes in the bulkhead and thus preserve the gas tightness of the bulkhead. The motors are fitted with field controls so that their speed may be regulated from 850 r. p. m. to 1150 r. p. m., thus varying the combined discharge of the pumps from 500 bbl. per hr. to 2000 bbl. per hr. against a head of 100 lb. per sq. in. without loss of efficiency. The Northern rotary pumps are provided with Northern reduction gears built in as an integral part of the pump unit.

One Worthington 2-stage volute pump, direct-connected to a 15 hp. motor, is installed in the engine room for fire and general service. A 3″x2″x3″ horizontal Worthington duplex pump, driven by whistle air, is set on brackets on the engine room bulkhead for use as a bilge pump. The ballast pump installed in the forward cargo hold is of the two-throw, double-acting, plunger type, built by Worthington and direct connected to a 5 hp. motor.

All of the equipment was selected with over-capacity to guarantee reliability and long life. The vessel, which was built at the Potrero plant of the Bethlehem Shipbuilding Corporation, performed to the entire satisfaction of the owners and proved a source of delight to those privileged to witness the trial and maneuvering tests.

Motorship Building in France

The Chantier et Ateliers de Saint Nazaire-Penhoët has just booked an order for the construction of two motor cargo vessels for a Norwegian owner, Wilh. Wilhelmsen. One of the ships will have a deadweight capacity of 9500 tons on a length of about 450 ft. and will have two B. & W. type engines developing 7400 i.hp. aggregate, the sea speed to be as high as 14½ knots. The other ship will have a deadweight capacity of 7000 tons on a length of about 377 ft. and will have two B. & W. engines developing a total of 3800 i.hp. The four engines will be constructed at the Penhoët works.

The same French builders have nearly completed for the same owner two 8500 tons d.w. cargo vessels, the TIJUCA and the TIGRE, and have an 11,000 tons cargo vessel under construction to the order of another Norwegian owner, Fred Olsen of Oslo.

With the latest order, the number of motorvessels under construction in France has been raised from 10 to 12, of which 8 are building to the order of foreign firms and 4 to French ship-owners' account.

Owing to a serious fire that took place in December in the passenger accommodation of the Dutch motor liner P. C. HOOFT, completing at the St. Nazaire yard of the Ateliers et Chantiers de la Loire, the delivery of that vessel will be postponed until July.

While French shipowners are still tardy in adopting Diesel engines, it is noteworthy that the construction of marine Diesel engines in France is making steady progress, thanks to the orders placed by foreign companies and by the French Navy. Special mention can be made of the order recently placed by the Navy for four 3000 b.hp. Sulzer engines to be installed on the two new 1500-ton submarines VENGEUR and REDOUTABLE. Two of the engines are to be supplied by the Cie. de Construction Mécanique Procédés Sulzer, while the two other Sulzer licensees in France (Ateliers et Chantiers de la Loire and Forges et Chantiers de la Mediterranée) will each construct one of the other two.

Diesel engine construction in France is also being stimulated by orders for submarines placed by foreign navies. The Greek Navy, for instance, has just placed with the Ateliers et Chantiers de la Loire and with the Chantiers Navals Francais an order for four 730 ton submarines, each to be fitted with two 600 b.hp. Sulzer engines.

H. P. Bingham's New Motoryacht Pawnee

Twin-Screw Boat for Yachtsman-Naturalist Is Larger and More Powerful Than the Old Pawnee

EARLY last month the first of the 1926 motor yachts was completed, a 160 ft. boat for Harry Payne Bingham, of the New York Yacht Club. She has been given the name of PAWNEE, which was formerly borne by the 145 ft. boat built in 1920 and owned for some time by Mr. Bingham. The new PAWNEE has the following chief characteristics:

Length o. a.	160 ft. 0 in.
Length, waterline	151 ft. 4 in.
Beam, extreme	26 ft. 6 in.
Depth, molded	15 ft. 6 in.
Draft	11 ft. 0 in.
Gross register	455 tons
Power (2 engines)	900 s.hp.
Sea speed (designed)	13 knots

PAWNEE is a steel vesesl designed by Cox & Stevens and built by the Newport News Shipbuilding & Drydock Co. with Winton engines. Like most yachts of about this size, her under deck space is utilized for accommodation of officers and crew forward, engine room amidships and staterooms for owner and guests aft.

On deck there are two steel houses joined by a continuous shade deck, at the forward end of which is a deckhouse containing the wheel room, chart room and captain's room with bath attached. The forward deck house on the main deck contains the dining room, pantry, and galley. All the lights fitted in this deckhouse are of elliptical form and of large dimensions carried in heavy bronze frames which permit them to be opened in such a way that they can serve as air scoops. They are understood to be of a design patented by Blohm & Voss of Germany.

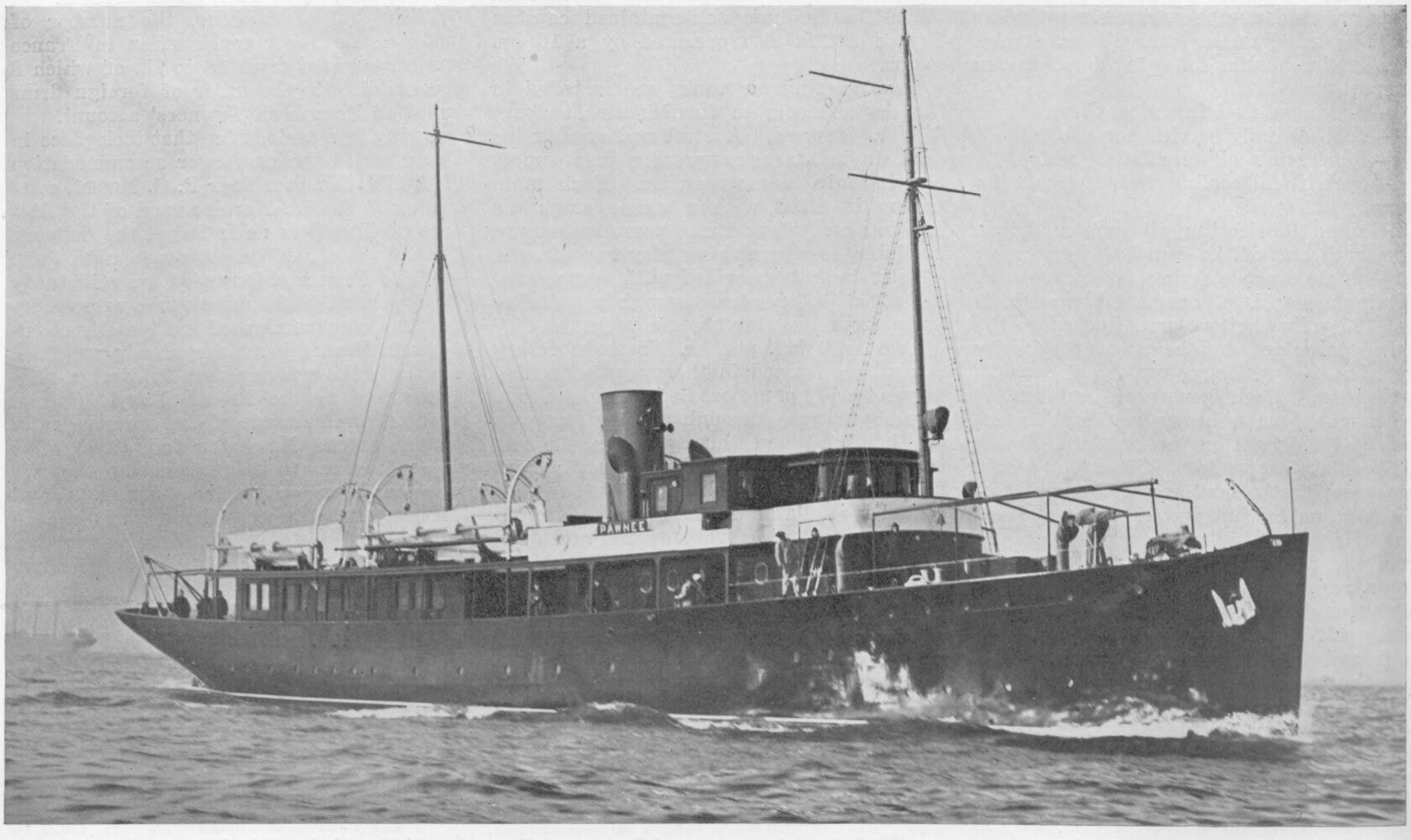
In the after deckhouse are the living room, a taxidermist room and a laboratory. These two latter rooms are for the personal use of the owner, who makes a hobby of marine biology. In a shelter at the after end of the steel house there is a large aquarium tank.

On the shade deck the space is not cramped, although it is lined with small boats, including a fast owner's launch 25 ft. long, and a heavy fishing launch of the same length, a 21 ft. crew's launch, a sailing lifeboat and a 14 ft. dinghy.

In the engine room there is more space than is usually provided in yachts of this size. The two main propelling engines are 6-cylinder Winton Diesels turning at 280 r.p.m. and delivering an aggregate of 900 s.hp. These engines are a well-tried Winton type of heavier construction than the new series of models brought out last year. They have the separate cylinder construction and are characterized by a long shaft extending the full length of the engine on the inboard side and driving the fuel injection pumps, camshaft gear and the six auxiliary pumps, of which four are for different water services and two for the bilge. These engines have an eccentric adjustment on the fuel valve rockers to permit variations to be made in the fuel valve opening to correspond with changes of fuel and changes of injection presure.

Two generating sets are installed, both of 20 kw. and both driven by 35 hp. Diesel engines which consist of two cylinders of the new 105 model Winton engine. These generating sets are much more in harmony with the main engines than those generally fitted aboard yachts. Storage batteries also are provided. The generating capacity needed on this vessel is large because of the number of electrically driven units in the engine room and on deck. In addition to the electric anchor windlass on deck there are also electric winches for hoisting the boats, and an electric winch for operating the trawl gear aft.

In the engine room all the pumps are electrically operated. There are two 5 hp. Kinney fire and bilge pumps, a 1 hp. Viking fuel oil transfer pump, a ½ hp. Kinney pump for transferring the lubricating oil between the tanks, engine bases and filters as required, a Kewanee sanitary pump and an electric pump submerged in the sanitary sump tank with automatic control, this device being the product of the Thomas Pump Works. The other machinery in the engine room consists of a 2-ton Brunswick Kroeschell ice machine and a Holyoke water heater with kerosene burners. The exhaust from all the engines is carried into the stack, on which are mounted two Tyfon whistles.



New m.y. Pawnee, 455 tons gross, fitted with trawling gear, marine laboratory, taxidermist room and aquarium, for Harry Payne Bingham

Many Motoryachts Now Under Construction

Fifteen Large Diesel Engined Boats to Be Built or Converted for Prominent Yachtsmen

A LARGE number of motoryachts are under construction in American yards at the present time. There has clearly been a change in the attitude of yachtsmen towards the placing of orders abroad. A couple of years ago nearly all the new Diesel-engined yachts came from the other side and none were built in American yards. The situation has so far changed that there are today about 12 large motoryachts built or being converted in American yards.

In point of size the largest of the yachts now receiving Diesel engines is Cyrus H. K. Curtis' 800 ton LYNDONIA, built in 1920 at Morris Heights with triple expansion engines. She is a twin screw boat of 210 ft. registered length, 30 ft. beam and 15.8 ft. depth. Less than six years after she was completed as a steam yacht she has had her machinery ripped out and is having two 700 s.hp. six-cylinder Burmeister & Wain type engines installed at Cramp's yard in Philadelphia.

The largest of the yachts under construction is the ARCADIA for Galen L. Stone of Boston and New York which will be 188 ft. overall length, with 28 ft. beam and a depth of 16 ft. Her propelling machinery will consist of two Winton Diesel engines of the new 800 hp. model, which are expected to drive her at a speed of 16 knots.

Close to her in point of size will be the SAVARONA building for R. N. Cadwalader, Jr., of Philadelphia. She will be 185 ft. long with a beam of 27 ft. and a depth of 16 ft. Her propelling machinery will be similar to that of the ARCADIA, consisting of two 800 hp. Winton engines, which will drive her at a speed of about 16 knots. She, like the ARCADIA, has been designed by Cox & Stevens, and both boats are being built by the Newport News Shipbuilding & Drydock Co.

A 171 ft. yacht, which will have two Bessemer engines aggregating 1600 s.hp. is building for D. P. Davis of St. Augustine, Fla., at Todd's Tebo yard in Brooklyn, N. Y. She has not yet been named. Her design is by Henry J. Gielow, Inc.

For Jesse L. Livermore of New York, a large boat ADHERO II is being built to Gielow designs at Lawley's yard near Boston. She will measure 170 ft. overall length, with a molded beam of 27 ft. 4 in. and will be driven by two 6-cylinder Bessemer engines turning at 250 r.p.m. and developing an aggregate of 1600 s.hp. She is intended to be used largely for commuting between the owner's summer home on Long Island and New York, but will be of a seaworthy type suited for extended ocean service.

Two boats of about 160 ft. length are under construction at the Newport News S. B. & D. D. Co. for Mr. Chisholm and for Commodore Robert Law, Jr., of the Indian Harbor Yacht Club, respectively. The former will be known as the ARAS and will measure 162 ft. overall, 26 ft. beam and 15 ft. depth. She will have twin screws with an aggregate of 900 s.hp., which is expected to drive her at about 14 knots. Her design being by the Bath Iron Works, which in the past designed and built many fine steam yachts, she will probably present features differentiating her considerably from the other boats. One of the departures, for instance, from usual practice is her double bottom.

Mr. Law's boat, ROBADOR, will be very slightly shorter, but a trifle deeper, her dimensions being 161 ft. overall length, 26 ft. beam and 16 ft. draft. Her main engines will be two 450 hp. Wintons, expected to drive her at about 14 knots. She will be unusual in having the crew's quarters aft, the forward space all being given up to the accommodation for the owner and guests.

There is a third boat of 160 ft. length on order, but her construction has not yet been commenced and she may not be completed this year. She is a fast boat which Carl Fisher of Sands Point, L. I., and Miami, Fla., has ordered from the Purdy Boat Co. of Port Washington, L. I., and for which the Bessemer Gas Engine Co. is building two 12-cylinder Diesel engines, from which Mr. Fisher hopes to get 6000 s.hp. Mr. Fisher understands well that the task he has set the engine builders is exceedingly difficult and to be regarded more as development work than as anything else.

For D. C. Whitney of Detroit, Mich., there is also a 160 ft. yacht under construction. She has been designed by Henry J. Gielow, Inc., and is building at the Brooklyn yard of the Todd Drydock Engineering & Repair Corp. Her main engines will be two 6-cylinder Bessemers, developing an aggregate of 850 s.hp.

Another Great Lakes yachtsman represented in the list of those who have boats under construction is E. S. Burke, Jr., of Cleveland, Ohio. His boat, JOSEPHINE, which will measure 140 ft. by 24 ft. by 13 ft. depth is now under construction at Newport News to designs by Cox & Stevens. Her propelling power will be provided by two Winton engines developing a total of 550 s.hp. and expected to give her a speed of 12½ knots.

At the Pusey & Jones yard at Wilmington, Del., a Diesel-engined yacht is under construction for John H. French. She will measure 124 ft. by 20 ft. by 12 ft.

The list of new boats building in the East includes also the NEVADA, now under construction for DeVer H. Warner of Bridgeport, Conn., at Nevins' yard, City Island, N. Y., from designs by Tams & King. She will measure 110 ft. overall and

List of Diesel Powered Yachts under Construction and of Yachts Being Converted to Diesel Power

Yacht	Owner	Length	Breadth	Depth	Yacht Builder	Power	Engine Builder	Speed	Designer
LYNDONIA	Cyrus H. K. Curtis	210 ft.*	30 ft.*	15.8 ft.*	W. Cramp & Sons.†	1400 s.hp.	Burmeister & Wain	......	Consolidated S. B. Co.
ALOHA	Comm. A. C. James	180 ft.*	35.5 ft.	17 ft.	Staten Island S. B. Co.†	825 s.hp.	Winton	10 knots	Tams & King
ARCADIA	Galen L. Stone	188 ft.*	28 ft.	16 ft.	Newport News S. B. & D. D. Co.	1600 s.hp.	Winton	16 knots	Cox & Stevens
SAVARONA	R. N. Cadwalader, Jr.	185 ft.*	27 ft.	16 ft.	Newport News S. B. & D. D. Co.	1600 i.hp.	Winton	16 knots	Cox & Stevens
———	D. P. Davis	170 ft.	..	..	Todd Shipyards Corp.	1600 i.hp.	Bessemer	16 knots	H. Gielow, Inc.
ADHERO II	Jesse L. Livermore	170 ft.	27.3 ft.	..	Geo. Lawley & Son.	1600 i.hp.	Bessemer	16 knots	H. Gielow, Inc.
ARAS	H. P. Chisholm	162 ft.*	26 ft.	15 ft.	Newport News S. B. & D. D. Co.	900 i.hp.	Winton	14 knots	Bath Iron Works
ROBADOR	Com. R. Law, Jr.	161 ft.*	26 ft.	16 ft.	Newport News S. B. & D. D. Co.	900 s.hp.	Winton	14 knots	Cox & Stevens
SHADOW X	Carl Fisher	160 ft.	..	..	Purdy Boat Co.	6000 s.hp.	Bessemer	34 knots	Purdy Boat Co.
SUMAR	D. C. Whitney	160 ft.	..	..	Todd Shipyards Corp.	850 s.hp.	Bessemer	......	H. Gielow, Inc.
JOSEPHINE	E. S. Burke	140 ft.*	20 ft.	13 ft.	Newport News S. B. & D. D. Co.	550 s.hp.	Winton	12½ knots	Cox & Stevens
———	John H. French	124 ft.	20 ft.	12 ft.	Pusey & Jones	....	......	......	......
SUEJA II	Capt. Griffiths	116 ft.	19 ft.	..	Winslow Marine Railway	360 s.hp.	Washington-Estep.	11½ knots	L. E. Geary
NEVADA	DeVer H. Warner	110 ft.	20.5 ft.	..	Nevins Yard, City Island, N. Y.	300 s.hp.	Standard	11½ knots	Tams & King
ALPHA	G. Marshall Ellis	100 ft.	..	..	Welin Boat & Davit Co.	300 s.hp.	Bessemer	11½ knots	H. Gielow, Inc.

* Registered dimensions. † Yard where conversion is being made.

20 ft. 6 in. beam. Two Standard engines developing together 300 s.hp. will be installed and give her a speed of probably 11½ knots.

A 100 ft. boat of Gielow design has been ordered by George Marshall Ellis of Morristown, N. J., and will be known as the ALPHA. She is being built by the Welin Boat & Davit Co. and will have two Bessemer engines of 300 s.hp. aggregate.

Of an entirely different character to all the other yacht work is the conversion of the ALOHA's auxiliary power. This famous bark, owned by Commodore Arthur James, is having her steam machinery replaced by a Diesel-electric system at the yard of the Staten Island Shipbuilding Co. She is 180 ft. registered length and measures 218 ft. overall and 165 ft. 10 in. on the water line. Her new power plant will consist of three Winton engines aggregating 825 s.hp., direct connected with Westinghouse generators of 175 kw. with 30 kw. exciters. These furnish power to a 640 hp. propulsion motor driving the single screw. This power will be in excess of her former steam power and is expected to drive the ALOHA under bare masts at 10 knots. ALOHA was originally designed by Tams, Lemoine & Crane, and Tams & King are supervising the conversion.

New Diesel Electric Dredge

BEFORE the close of navigation on the Great Lakes the SANDMASTER, a Diesel-electric hopper dredge for the Construction Materials Co. of Chicago, made the trip from Cleveland, O., where she had been converted, to Chicago. She will be the first Diesel-electric dredge to operate on the Great Lakes and will be used also for transporting and delivering construction materials for building purposes.

Formerly the LAKE WEIR, this vessel, which was a steamer, measures 261 ft. b.p., 43.7 ft. beam and 19.2 ft. registered depth. Her new propulsion equipment consists of two 600 b.hp. Diesel engines built by the Worthington Pump and Machinery Corp., each direct connected to a 400 kw. main generator and a 50 kw. auxiliary generator. Under normal operating conditions each main generator drives a 500 hp. motor direct connected to a propeller, the vessel being of the twin-screw type. Ward-Leonard control is used, providing independent control of each propelling motor, and arranged for operation from either the pilot house or engine room. Provision is also made for operating both propelling motors from one generator alone.

One auxiliary generator furnishes excitation for the motors and generators and the other is used for furnishing power for driving the engine room auxiliary motors, steering gear and lighting. All the auxiliaries are electrically driven.

In addition to the propulsion equipment, there are provided two 400 hp. motor-driven dredging pumps, the power for which is taken from either or both of the main generators. Under one condition of operation both dredging pumps are driven from one generator while the other generator furnishes power for propulsion. Under another condition of operation, when no propulsion is required, each dredging pump is connected to a main generator and operates independently.

Included among the electric auxiliaries, besides the steering gear, are two 10 hp. pumps, six 5 hp. pumps, one 50 hp. pump, one 35 hp. anchor windlass, two 20 hp. mooring winches, one 20 hp. after anchor windlass, two 20 hp. suction hoists, two 125 hp. jet pumps and two 10 kw. motor generators for lighting.

World's Ship and Engine Construction

Lloyd's Register Reports Power of Diesel Engines Now Building Exceeds Aggregate Power of Steam

AT the end of 1925 the total tonnage of ships under construction throughout the world was actually less than 2,000,000 tons, of which motorships accounted for more than 50 per cent. The statistics issued by Lloyd's Register of Shipping indicate a total of 2,069,545 tons, but this includes about 113,000 tons on which work has been suspended. Work is proceeding on the construction of only about 1,950,000 tons.

Due, however, to the fact that the summary released by Lloyd's does not segregate the motor vessels and steamers in the tonnage of suspended work we are forced to include in the tabulation below all the vessels on which work has been started. It is known that the tonnage of the steamers on which no further work is being done is very close to 100,000 tons. If exact account could be taken of this in the tables presented herewith the fact would be clearly shown that the motorship tonnage now under construction exceeds the combined totals of steamers and sailing vessels.

There has been a decrease of about 400,000 tons since the end of 1924 due to a reduction of about 500,000 tons in the steamer tonnage, against which is offset an increase of about 80,000 tons in the motorship tonnage.

Lloyd's figures for the world are intended to cover all merchant craft exceeding 100 gross tons, but do not include yachts, and of course, do not include naval construction. The huge task of collecting the figures from all countries cannot be expected to be accomplished without omissions and possibly a few errors. The omissions are particularly noticeable in the case of the United States.

Lloyd's figures for this country are never as large as those compiled by the Department of Commerce, and the Department of Commerce figures are not comprehensive. No satisfactory returns are in fact available for the United States. According to Lloyd's this country now takes sixth place in rank of construction; the leading countries are the United Kingdom, with Italy second, Germany third, France fourth and Holland fifth. The rise of Italy in the list is very striking. There are now over 300,000 tons of shipping under construction there.

Last June Lloyd's Register commenced the collection of statistics relating to the different classes of machinery under construction for vessels throughout the world. The figures for the end of 1925 show that the power of the Diesel engines now building exceeds the aggregate of the power of all types of steam machinery. The steam turbine figures are dwindling very noticeably. Italy stands third in the engine building list with an aggregate of 107,560 i.hp. The United Kingdom leads with 235,017 i.hp., followed by Germany with a total of 128,410 i.hp. These engine figures are seriously in error for the United States, due very largely to the fact that 50,000 i.hp. under construction for the Shipping Board conversions is not included.

Lloyd's figures give a good indication of fluctuations in the shipbuilding industry in general throughout the world, but are not to be accepted as an indication of shipbuilding or marine engineering activities in the United States. For this reason we do not use Lloyd's segregated figures for this country.

World Building of Motorships and Steamers During the Year 1925

	DEC. 31 1924	MARCH 31 1925	JUNE 30 1925	SEPT. 30 1925	DEC. 31 1925
Motorships	923,738 tons	1,021,631 tons	1,129,912 tons	1,088,888 tons	1,007,381 tons
Other types	1,546,698 tons	1,375,279 tons	1,239,919 tons	1,090,456 tons	1,062,164 tons
Total building	2,470,486 tons	2,396,910 tons	2,369,831 tons	2,179,344 tons	2,065,545 tons
Motorships	37 per cent	42 per cent	48 per cent	50 per cent	49 per cent
Other types	63 per cent	58 per cent	52 per cent	50 per cent	51 per cent

Marine Machinery Under Construction Throughout the World

	JUNE 30 1925	SEPT. 30 1925	DEC. 31 1925
Diesel engines	808,624 i.hp.	726,845 i.hp.	788,758 i.hp.
Steam turbines	353,144 i.hp.	318,045 i.hp.	283,950 i.hp.
Steam reciprocating engines	559,970 i.hp.	478,515 i.hp.	450,676 i.hp.
Total all types	1,721,738 i.hp.	1,523,405 i.hp.	1,523,384 i.hp.
Diesel power	47 per cent	48 per cent	52 per cent
Steam power	53 per cent	52 per cent	48 per cent

Use of Radio Compass Fast Extending

Its Aid to Safety of Navigation Now Becoming Recognized by Progressive Shipowners Everywhere

FOG is the greatest menace to safety of navigation at sea, and a large proportion of marine disasters, strandings and collisions have been due to fog and other conditions of low visibility. Ships cannot always afford to stop when the navigator is unable to see through the fog, and in some positions it is not safe to do so because of current or wind or lack of suitable anchorage.

Lights for guiding navigators have been provided for more than 2000 years, and within the last century many important advances have been made in illuminating apparatus, greatly increasing the brilliancy and efficiency of lights, but when fog covers the sea and the mariner is more urgently in need of help, the most powerful combination of light and lens is rendered useless to him.

When approaching the coast and when meeting other vessels the navigator is dependent mainly on bearings for the safe navigation of his ship, but until recently he has never had available a means of obtaining bearings on invisible objects.

In the nearly 30 years since wireless telegraphy was proved practicable it is doubtful if any use of radio has been found of greater value to the services of man than the application of radio direction finding in navigation, for in this case, as also in the matter of communicating with vessels at a considerable distance, radio satisfied a great need, previously entirely unfilled.

Provision of aids for vessels in fog has not in the past kept pace with the development of lighthouse illuminating apparatus, because the difficulties of the problem were obviously greater. The first fog signal in this country was a gun placed at Boston Light in 1719, fired at intervals to answer ships in a fog.

A hundred years later in 1820 there is the first mention of a fog bell. Since then there has been considerable development and improvement of sound producing fog signals, but the use of these has been lacking in two of the most essential requisites of efficient navigational aids, namely, the means of taking an accurate bearing and the certainty of reception under varying conditions and at sufficient distances, although the submarine signal made an advance in the latter respect.

It was in 1921, another hundred years later, that the first successful fog signals were established, with a system rendering possible the taking of accurate bearings on shipboard from considerable distances, regardless of weather conditions. These were the three radio fog signals placed in the approaches to New York, at Ambrose Lightship, Fire Island Lightship and Sea Girt Lighthouse.

United States Leads

When the well known conservatism of the sea, the complications of conflicting sytems and the expense are considered, the progress made in less than five years in the development and introduction of this system of radio navigation has been sufficiently great to prove that a really urgent need is being successfully met.

At the present time 24 radio fog signals are in operation on the coasts of the United States, and these cover fairly well the principal points on the Pacific and North Atlantic coasts, with some stations on the Great Lakes and the Gulf coasts, and apparatus is being provided for four other stations, including one in Alaska. There are about the same number of radio fog signals, 23, to be exact, in operation on the coasts of other countries, including Canada, Newfoundland, Great Britain, France, Spain, Germany, Norway and Denmark.

Radio compass frame on m.s. East Indian

In addition to the regular radio fog signals, there have recently been listed 157 radio stations throughout the world on which bearings may be taken from ships equipped with radio compasses, and many of the stations will, on request, transmit signals to permit bearings being taken. A special signal for this purpose has been prescribed, QTG, meaning: "Please transmit your station's call sign for one minute, in order that a direction finding bearing may be obtained." About 500 vessels are now equipped with radio compasses or direction finders for taking radio bearings from the ship, not including the naval vessels of the various countries.

Radio compass frame on m.s. Henry Ford II

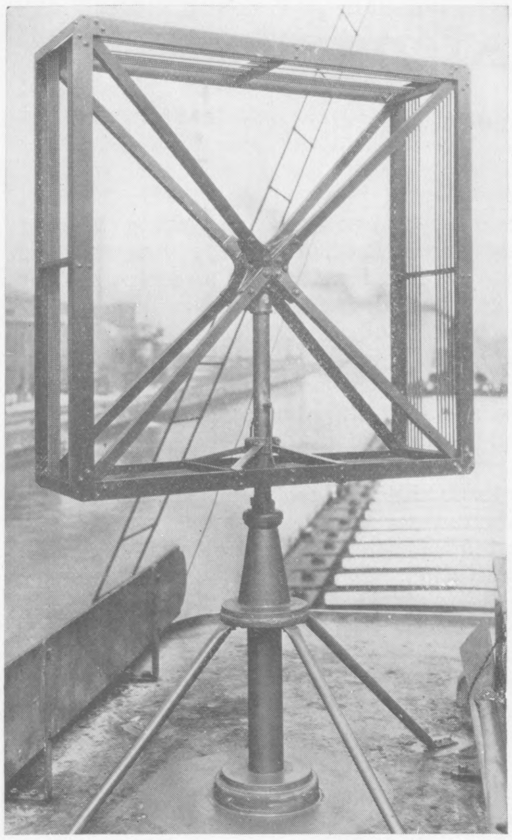
Radio has been found of value to the operation of ships in a number of ways, and there are also several methods of applying radio direction finding and directive radio to ship navigation proper. The system referred to above, however, is the only system of using radio bearings of general application. It comprises the provision on the ship of an instrument capable of observing the direction of a radio signal and the installation at fixed stations or on other vessels of means of emitting radio signals which may be identified with the source from which they come.

It is true that the reverse of this arrangement has been developed, that is, a system of placing radio compass stations on shore, taking bearings of ships, sending signals and communicating the bearing or computed position to the ship. A considerable number of such shore stations maintained by various governments, and particularly by the United States, are now in operation, and have been useful to vessels not provided with radio compasses, pending the extension of the use of such compasses on shipboard. With the successful operation of ships' radio compasses these should no longer be looked upon as rival systems.

The shore compass station fails to give to the navigator several of the great advantages of radio direction finding, including the ability to take bearings of approaching vessels or of ships in distress, the ability to take bearings in any part of the world on ships or stations, and the ability to take repeated bearings at the option and under the supervision of the navigator. If dependence for the use of radio bearings be placed solely on compass stations ashore, a navigator would be deprived entirely of this valuable aid when his ship happened to be out of the reach of the regularly maintained compass stations or when the vessel is not equipped for radio communication service or when meeting or seeking other vessels. Navigators would also be dependent on the relative merit of management of the shore stations, which has been shown to vary greatly, and there is no redress for inaccurate bearings from a shore station.

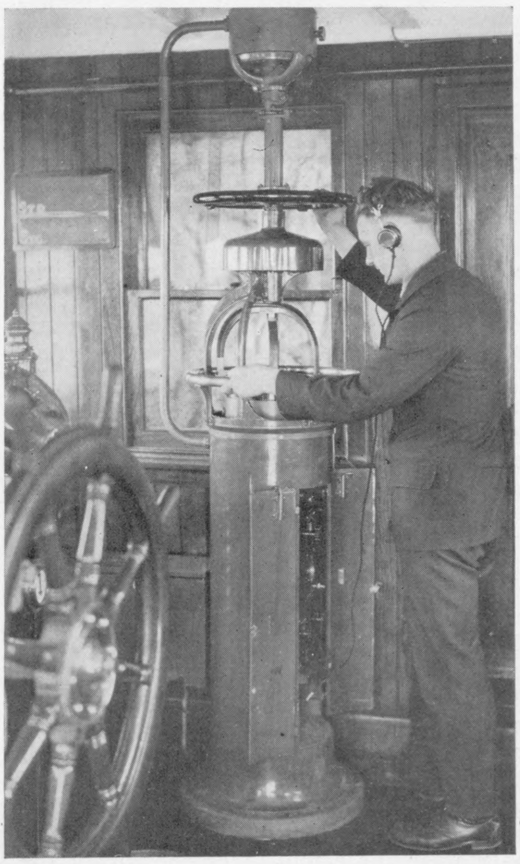
Leave Responsibility on Navigator

With the radio compass on shipboard the taking of bearings is under the supervision of the navigator, exactly as are all other observations used in navigating the ship. He can use such checks as he deems best and will soon know what reliance to place on radio bearings in comparison with all other means of guiding the vessel. There is no law of the sea more fixed than that established by long custom of placing on the master the complete responsibility for the navigation of a vessel.



Kolster type radio compass frame

The idea of navigating a vessel by bearings taken on shore by observers not under the control of the master is not in harmony with the usual principles of navigation, and such a departure would only be justified by inability to get the needed information in any better way, which is not true of radio bearings. A navigator would be astonished at anyone proposing to furnish him directional bearings taken visually from a lighthouse in place of those he might take with his instrument from his own ship.



Kolster type radio compass bearing finder

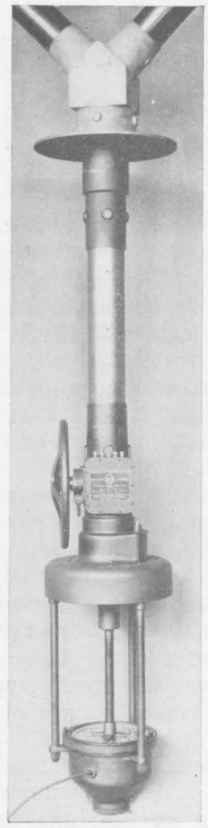
The expense of shore radio compass stations is so great that it is unlikely these stations will be generally placed throughout the coasts of the world, and therefore vessels depending on this system will be served only in limited areas. On the other hand it is quite feasible at a moderate expense to extend the radio fog signals, so far as needed, to all coasts equipped with lighthouses, that is, to all the coasts of the world. The cost of equipment is less than for first class sound fog signals, and the cost of maintenance is small, because the radio signals are operated by the present lightkeepers without any increase of force.

Besides the broad advantages of the radio compass on shipboard above stated, there are some other important practical advantages. The shore compass system fails in the approaches to an important port, because only one ship can be served at a time and the air congestion due to a number of vessels seeking bearings may be such as to cause delays which cannot be tolerated in efficient navigation. With the compasses on shipboard any number of vessels may take bearings simultaneously without interference with each other. Radio fog signals placed on lightships or stations suitably located are valuable leading marks for which to steer, a use for which the shore compass stations do not serve.

Sources of difficulty and error in the use of radio compasses on shipboard have occurred, but these appear to be capable of elimination with care, and there has been steady improvement of apparatus. Similar difficulties arise with the shore compass stations, which are by no means free from records of erroneous bearings. From its very nature, navigation is an art requiring constant care, vigilance, and checking of results. So fundamental a principle as that of retaining the responsibility on the ship should be adhered to, and a system that ignores this invites disaster, as experience has shown. Many reports of the value of the radio compass in navigating the ship, in meeting vessels, and in seeking ships in distress, have been published, and it is not necessary to relate these here.

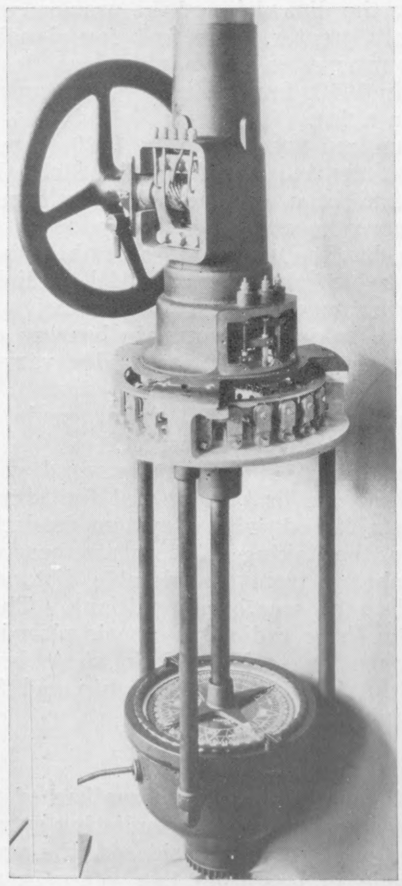
Radio Compass Wins

The real advantages of the radio compass on shipboard have been somewhat obscured by the extensive free service from the shore stations, as compared with the cost of ship installations. This has tended to delay the introduction and use of ship radio compasses. The training considered desirable for the personnel at shore stations is also necessary for work from the ship, but of course the more a ship depends on bearings supplied to it the less practice its officers will have in taking bearings themselves. That free service is an important factor is shown by the fact that the charge imposed in England for radio bearings given by a shore station has a decided effect in limiting the number of such bearings asked for by ships. So far as navigation of the vessel is concerned, the superior advantages of the compass on shipboard are the same for government vessels as for the commercial vessel. For military purposes the compass on shipboard has great value in the ability it gives of taking bearings on other vessels and shore stations everywhere and at all times.



R. C. A. type radio compass bearing finder

Besides the general system of navigation with radio compasses on shipboard, there are several more limited special uses of radio, which have developed or which indicate useful possibilities. The most widely used of these is the system of radio compass shore stations referred to above. Another system is the revolving radio beam on shore, a radio projector so designed as to revolve a concentrated radio beam around the horizon, enabling a ship properly equipped to obtain its direction. It is limited to fixed stations, cannot be placed



Close-up of R. C. A. type bearing finder

on a lightship and does not fulfill the general uses of the radio compass on shipboard, but it has the advantage of being independent of other radio service on the vessel. Three such stations are in operation. A fixed radio beam has also been tested experimentally with some success, but its use would be limited to furnishing a direction in fog similar to the use of range lights for leading marks in clear weather navigation.

Below is a list of the radio fog signals now in commission on the coasts of the United States, with their principal characteristics. These stations transmit signals in thick or foggy weather and also in clear weather for two ½-hour intervals each day, excepting that at the most important station, Nantucket Lightship, which is the leading mark off the United States coast for most of the transatlantic traffic, the signal is operated in clear weather for 15 min. of every hour. This additional operation of the signals is not only to permit testing and calibration of equipment, but also to allow the taking of bearings in clear weather, because radio bearings may be observed at much greater distances than sight bearings and such long distance bearings may be useful at times, particularly in approaching the coast.

In so important and radical a change in navigational methods, future development must necessarily be guided largely by experience and improvements of apparatus. The following additional stations are planned in the preliminary project for the coasts of the United States:

Proposed U. S. Radio Fog Signals

ATLANTIC AND GULF COASTS

Mt. Desert Lighthouse, Me.
Portland Lightship, Me.
Pollock Rip Lightship, Mass.
Montauk Point Light, N. Y.
Cornfield Point Lightship, N. Y. and other stations for the inside passage.
Winter Quarter Lightship, Va.
Cape Charles Lightship, Va.
Cape Lookout Lightship, N. C.
St. Johns River Lighthouse, Fla.
Jupiter Inlet Lighthouse, Fla.
Dry Tortugas Lighthouse, Fla.

GREAT LAKES

Superior Entry Lighthouse, Wis.
Milwaukee Lighthouse, Wis.
Chicago Harbor Lighthouse, Ill.
Lansing Shoal, Mich.

ALASKA

Scotch Cap Lighthouse.
Seal Rocks Lighthouse.
Cape St. Elias Lighthouse.
Cape Spencer Lighthouse.
Resurrection Bay Entrance.
Cape Decision.

PACIFIC COAST

Grays Harbor Lighthouse, Ore.
St. George Reef Lighthouse, Calif.
Point Arena Lighthouse, Calif.
Los Angeles Harbor Lighthouse, Calif.
Point Loma Lighthouse, Calif.

HAWAIIAN ISLANDS

Makapuu Point.

An important advance in the operation of the radio fog signal stations in this country was made in 1924 in substituting an electron-tube transmitter, for the spark transmitter, at Ambrose Lightship. This has worked satisfactorily, materially reducing interference and increasing the range and efficiency of the signal. Tube transmitters have been installed at recently established stations, and their substitution at the more important of the earlier stations is contemplated.

Plans are under way for the test of other improvements. It is proposed to control adjacent radio fog signal stations by synchronizing clocks, so as to prevent overlapping and interference between these stations themselves. It is also planned to try out installation of moderate power radio fog signals to aid vessels in inside waters where there is heavy traffic, as, for example, in Long Island Sound and the passages off Cape Cod.

Important fog signal stations, as Nantucket Lightship, are now equipped with three distance fog signals, radio, sound in air and sound in water, the radio and submarine signals being synchronized to give a means of estimating distance. There is no present prospect that the sound signals can be discontinued because of the radio signals. The menace of fog is so serious, and the resulting losses of life and property have been so great that the cost of more than one system of radio aids to navigation would be justified if really necessary and valuable in furnishing adequate protection.

In the art of navigation it is particularly important to avoid confusion, unnecessary complication and divided responsibility. Radio direction finding is amply proven to be of the greatest value, and provision for taking radio bearings from the ship is the only general system. The use of any other system should be so limited as not to retard or interfere either directly or indirectly with the practice of taking bearings from ships. The questions involved are of the first importance in ship navigation.

Radio direction finding has filled one of the greatest deficiencies in navigation by making it possible to take bearings of invisible objects, and further important progress and improvements in its use may confidently be expected.

U. S. Radio Fog Signals

		CHARACTERISTIC	
	SIGNAL	SOUNDED SEC.	SILENT SEC.
ATLANTIC AND GULF COAST			
Boston Lightship, Mass.	—.	55	20
Nantucket Lightship, Mass.	— — — —	60	30
Fire Island Lightship, N. Y.	— —	50	15
Ambrose Channel Lighthsip, N. Y.	—	65	25
Sea Girt Lighthouse, N. J.	— — —	30	180
Five Fathom Bank Lightship, N. J.	—...	40	25
Cape Henry Lighthouse, Va.	.. —	60	120
Diamond Shoal Lightship, N. C.	— —	30	30
South Pass Lighthouse, La.	— —	60	60
Galveston Harbor Lighthouse, Texas.	—	60	45
GREAT LAKES			
Buffalo Lighthouse, N. Y.	—	60	60
Detroit River Lighthouse, Mich.	— —	50	70
Lake Huron Lightship, Mich.	— — —	60	60
Detour Lighthouse, Mich.	— — — —	90	90
Whitefish Point Lighthouse, Mich.	—	60	120
Manitou Lighthouse, Mich.	— —	60	90
Devils Island, Wis.	— — —	60	60
PACIFIC COAST			
Swiftsure Bank Lightship, Wash.	— —	60	30
Columbia River Lightship, Ore.	— — —	60	30
Cape Blanco Lighthouse, Ore.	—.	60	30
Blunts Reef Lightship, Cal.	—	60	120
San Francisco Lightship, Cal.	— —	60	60
Point Sur Lighthouse, Cal.	.— —.	60	90
Point Arguello Lighthouse, Cal.	— — —	60	45

Increase of Private Operation

Based upon a comparison between the privately owned vessels in operation a year ago and those in service at the present time, there was an improvement during the year 1925 in the activities of American privately owned shipping. The number of privately owned American ocean-going power vessels of 1000 gross tons and over engaged in foreign and domestic coastwise trades has increased from 941 on Jan. 1, 1925, to 1026 on Jan. 1, 1926, an increase of 8 per cent, while the gross tonnage involved shows a net increase of 391,367 tons or 11.7 per cent.

An analysis of this increase shows, in the overseas foreign trade, an increase of eight vessels operated, but a loss in the gross tonnage employed due to the decrease in the average size of the vessels employed.

The West Indies and Caribbean trade also suffered a loss during the year, attributed to reduction in the import of Mexican petroleum and a consequent decrease in the movement of other commodities in that trade. The decrease consisted of one passenger ship, 20 general cargo boats and 34 tankers, all being among the smaller vessels in this trade because the average tonnage of ships remaining in service shows an increase.

American coastwise and intercoastal trades showed the greatest improvement of any of the services, with an increase of 132 vessels and of 585,031 ton employed, distributed as follows:— Atlantic and Gulf coastwise, an increase of 100 vessels and of 373,033 tons; Pacific coastwise, a decrease of 9 vessels and of 15,657 tons; intercoastal movements, an increase of 38 vessels and of 174,504 tons; Hawaiian trade, an increase of 5 vessels and of 30,376 tons, and Porto Rican trade, an increase of 6 vessels and of 22,775 tons. These figures are based upon the latest report issued by the Bureau of Research of the Shipping Board.

Holland's First Passenger Motorliner

Indrapoera, a 15½ Knot Vessel, for the Dutch East Indies Line of the Rotterdam Lloyd

INDRAPOERA is the first passenger motor-liner built and engined by a Dutch firm. She belongs to the Rotterdam Lloyd S. V. Mij. and will be used by that company in its service to the Dutch East Indies. The company already owns two motor freighters the KEDOE and the WIERINGEN, but INDRAPOERA is its first passenger ship.

Characteristics of m.s. Indrapoera

Length o.a.	500 ft. 0 in.
Length b.p. (Veritas)	479 ft. 4 in.
Breadth, molded	60 ft. 0 in.
Depth to upper deck (at side)	38 ft. 0 in.
Gross register	10,772 tons
Net register	6,402 tons
Draft (summer)	28 ft. 10½ in.
Deadweight capacity	8,600 tons
Displacement, about	17,800 tons
Power (2 engines)	7,000 s.hp.
Sea speed about	15½ knots

INDRAPOERA was designed and built by the Kon. Mij. De Schelde, Flushing, Holland. Like most of the European vessels designed for tropical service, she has all passenger accommodation as high above the water line as possible in order that windows and sidelights can be kept open even in unfavorable weather. There are no inside cabins for white passengers and only a few for the native passengers and native crew. Public rooms have large sliding or hinged windows, and the promenade decks are all protected from the sun. She has accommodation for 141 passengers in 1st class, 182 in 2nd class, 68 in the 3rd class, 46 in the native class, 24 troops and 210 white and native crew, making a total of 671.

In order to obtain greater transverse sectional strength in the engine room several broad web frames are fitted on both sides of the ship, supporting the intermediate frames through a plate stringer at the height of the lower deck, which is not carried through the engine room. 'Tween deck, upper deck and superstructure decks above the engine room are supported by hollow pillars reaching from the double bottom to the 'tween deck and placed on the same frame numbers as the web frames just referred to. Plate beams are fitted under the 'tween deck in way of the web frame and pillars. Solid pillars occupying less space might have been utilized instead of the long hollow pillars, but when the period of vibration of the solid pillars was calculated there appeared to be a possibility that it would correspond with the period of vibration of the 4-bladed propellers, leading to resonance, which would have set up an undulating movement in the pillars and a corresponding vibration in the superstructure of the ship.

The main engines are built with cast iron bedplates resting directly on the heavily stiffened double bottom of the ship. The engines are of the Sulzer single-acting type, built at the De Schelde Works, and develop 3500 s.hp. each at 87 r.p.m.. They have each six power cylinders of 29.92 in. diameter and 54 in. stroke. This rating is on the basis of about 90 lb. per sq. in. m.i.p. and about 770 ft. per minute piston speed, these figures being kept low on account of the conservative opinions of the owner's engineering staff.

Scavenging air is supplied by electrically driven turbo blowers, of which there are two, each capable of supplying air for both main engines, whilst the second blower is kept in reserve. These pumps draw their air from a common duct with its inlet on the awning deck. They run at 2500 r.p.m. and absorb about 220 kw.

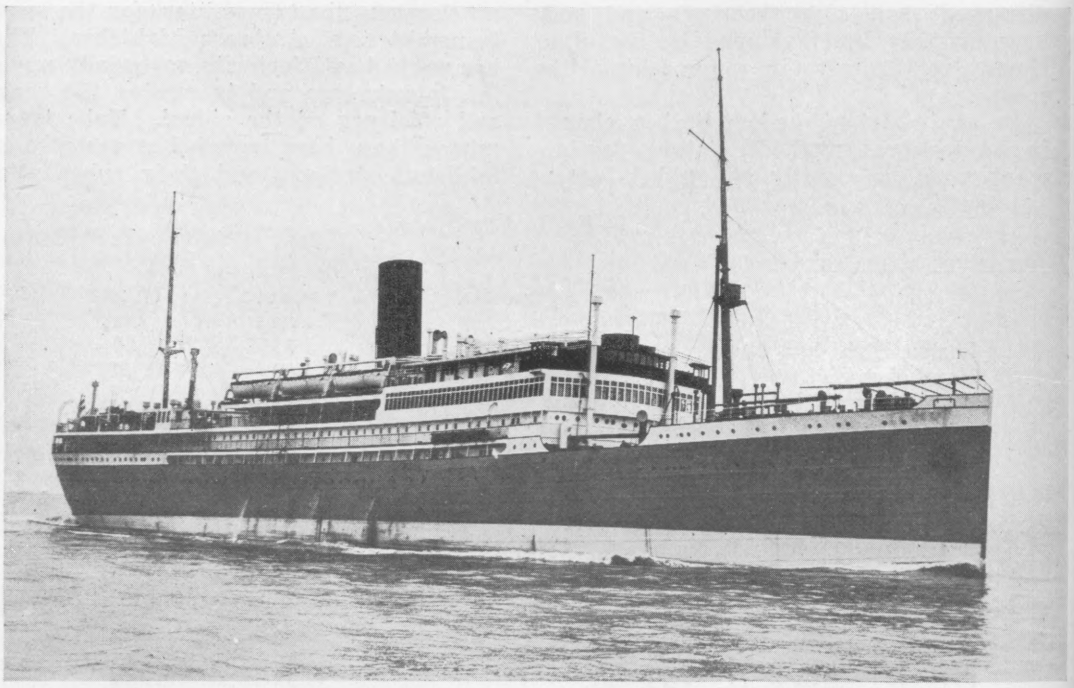
For the engine cooling, salt water is used in the cylinders and cylinder heads, but for the pistons fresh water is utilized, and for this purpose about 100 tons of fresh water is carried in the double bottom.

To comply with the recommendations of the Bulkhead Commission the machinery space is divided by a watertight bulkhead giving an auxiliary machinery space at the forward end of the main engine room, known on the ship as the pump room. In the main engine room are located, as far as possible, all the auxiliary units belonging directly to the propelling machinery.

There are four auxiliary Diesel generator sets, each of 410 b.hp. at 200 r.p.m. and of the 2-cycle Sulzer airless injection type. The idea underlying the adoption of four generating sets was that two would always be in operation at sea and one could always be held as a reserve even though the fourth was under inspection or repair. It is planned that no work should be done on the auxiliary sets whilst the ship is in port, the engineers devoting that time to the scheduled inspection of the main engines.

Though each main engine has its own oil pump for its forced lubrication system there is a separate stand-by lubricating pump electrically operated. Two Sharples oil centrifuges are installed for purifying the lubricating oil, one being for use while the other is being cleaned.

A complete Lux fire extinguishing installation has been installed, connections being made to each of the cargo holds and to the engine room. All of the deck machinery is electrically operated, there being six 3-ton winches and three 5-ton winches. The anchor windlass is electrically driven, and the warping capstans on the poop deck are electrically operated.



Indrapoera, 10,772 tons gross, the new motorliner of the Rotterdam Lloyd

To Wipe Out Losses

Two motorships ROMOLO and REMO which the Lloyd Triestino Line has ordered from the Stabilimento Tecnico Triestino are to be provided with accommodation for about 50 passengers. They will probably be placed in a regular monthly service between Trieste, Shanghai and Kobe. It is stated that the Lloyd Triestino is losing about $20,000 a voyage on its steamers in the Far Eastern service and expects to wipe out this loss by the use of motorships, even if there is no improvement in the freight.

ROMOLO and REMO will be about 485 ft. b.p., with a molded breadth of 62 ft., a molded depth of about 34 ft. and a deadweight capacity of 11,000 tons on 26 ft. draft. The gross tonnage of the vessels will be 9800, and two 6-cylinder engines of about 3400 s.hp. will drive them at a sea speed of about 13 knots loaded. There will be only one class passenger accommodation, and the cabins will all be either of the 1-berth or the 2-berth type. In addition to the dining saloon, music room, writing room and smoking room there will also be a veranda cafe. In the engine room, besides the two 6-cylinder main engines there will be four Diesel generating sets of 66 kw. capacity each. All auxiliary machinery throughout the vessel will be electrically operated, including 10 winches of 3-tons capacity and six winches of 5-tons capacity.

Features of New Type F. M. Marine Engine

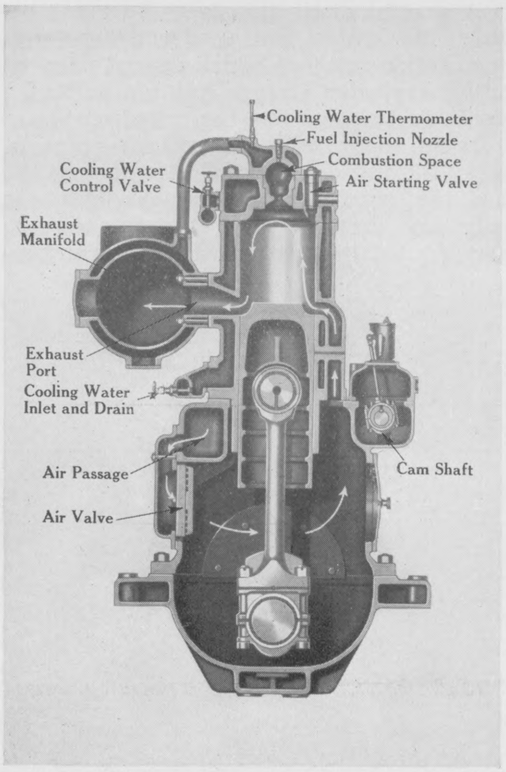
Well Known C-O Engine has been Developed into Airless Injection Type of Diesel

ONE of the results of the huge development program which has been in progress at the Beloit works of Fairbanks-Morse & Company has been the redesign of the type C-O engine. The new design is not, however, a radical departure from the well-known C-O engine, of which 150,000 hp. are in successful operation. The principal improvements are those which adapt the engine to the use of a wider range of low grade fuels, better fuel economy and means for immediate starting without the aid of auxiliary ignition devices.

Table of Engine Sizes

Power	No. of Cyls.	Speed Normal	Speed Range
360 hp.	6	250 r.p.m.	100-250 r.p.m.
240 hp.	4	250 r.p.m.	100-250 r.p.m.
180 hp.	6	360 r.p.m.	150-360 r.p.m.
120 hp.	4	360 r.p.m.	150-360 r.p.m.

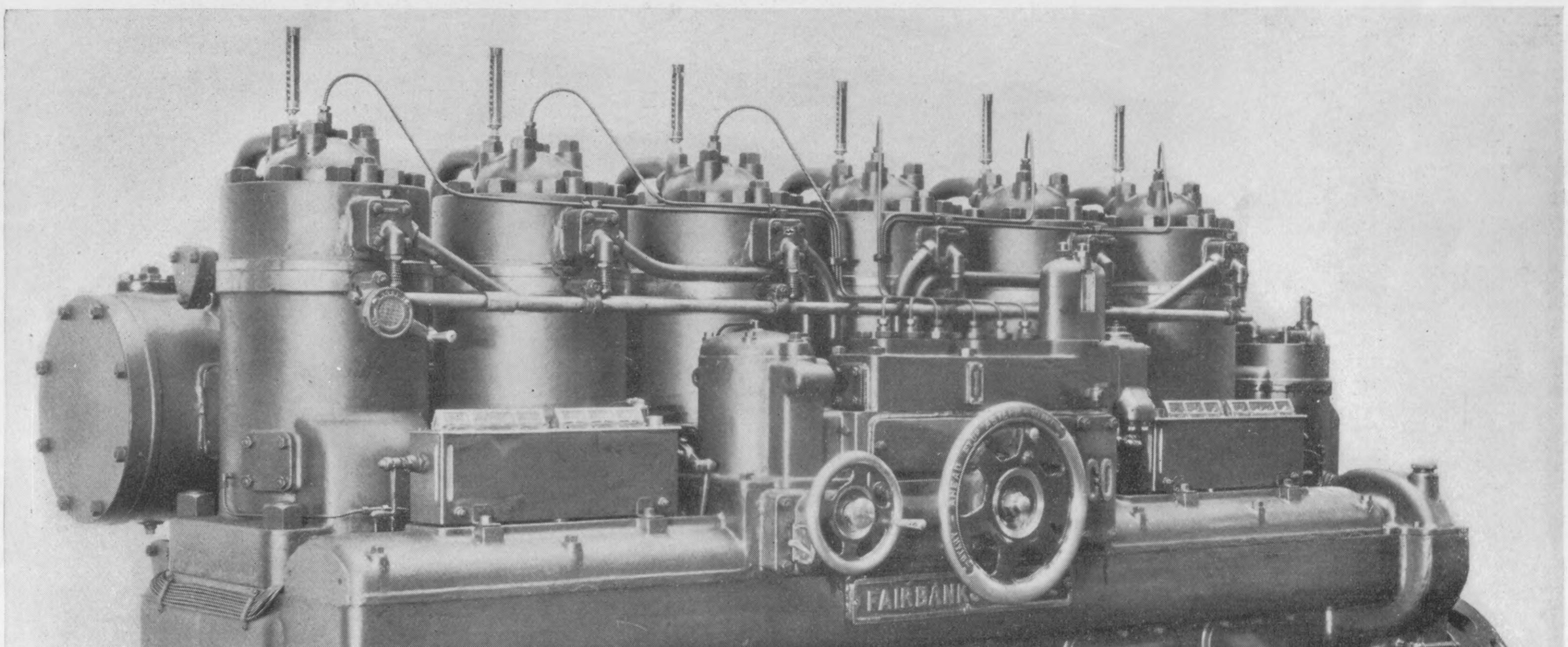
Two of the first points to strike the observer in the new design are the compactness and simplicity of the engine. While fundamentally due to the 2-cycle principle and to the use of airless injection, the simplicity is chiefly the result of careful design. All piping has been eliminated or enclosed, and the starting, reversing and governing mechanism has been worked out in a compact unit located at the center of the engine. The goal of the designers was to produce an engine of maximum simplicity and reliability, and that object has been achieved by thoroughness in the execution of the details. From end to end of the engine there is evidence of careful study of every detail.



Transverse section through cylinder

An interesting feature of the Fairbanks, Morse design is the use of what the engine builders term 2-stage combustion, the arrangement of which was worked out at the Beloit plant after extensive experimental research had demonstrated its many advantages.

A few degrees before the compression has been completed, i.e., near the top dead center of the piston travel, a spray of fuel is introduced into the combustion chamber through a nozzle centrally located at the top. Partial combustion, which results in burning the fuel charge in the pre-combustion chamber to carbon monoxide (CO) with the liberation of a relatively small amount of heat, takes place as the first stage of the process, and the liquid fuel that has entered the cylinder combustion space is gasified. Because of the partial nature of the first stage of combustion, there is no pressure rise of any consequence.



Front of the new type C-O engine with control stand in center and sightfeeds and lubricators in direct view

As the piston starts on the downward stroke, with the attendant rush of gases through the neck into the cylinder space, a considerable degree of turbulence and a thorough mixing of the air excess with the CO gas and oil vapor are brought about and the final combustion of the charge to carbon dioxide (CO_2) is completed.

Over 50 per cent of the heat due to the entire combustion is liberated in the second stage, but owing to the fact that the piston is then beginning to pick up considerable speed the expansion quite accurately neutralizes any rise in pressure which would otherwise result from the more intensive and complete 2nd stage combustion. So thoroughly has the system been worked out that flat top indicator cards are obtained, and the engine works with spontaneous ignition of fuel and complete burning unaccompanied by pressure rise, according to the method first conceived by Diesel.

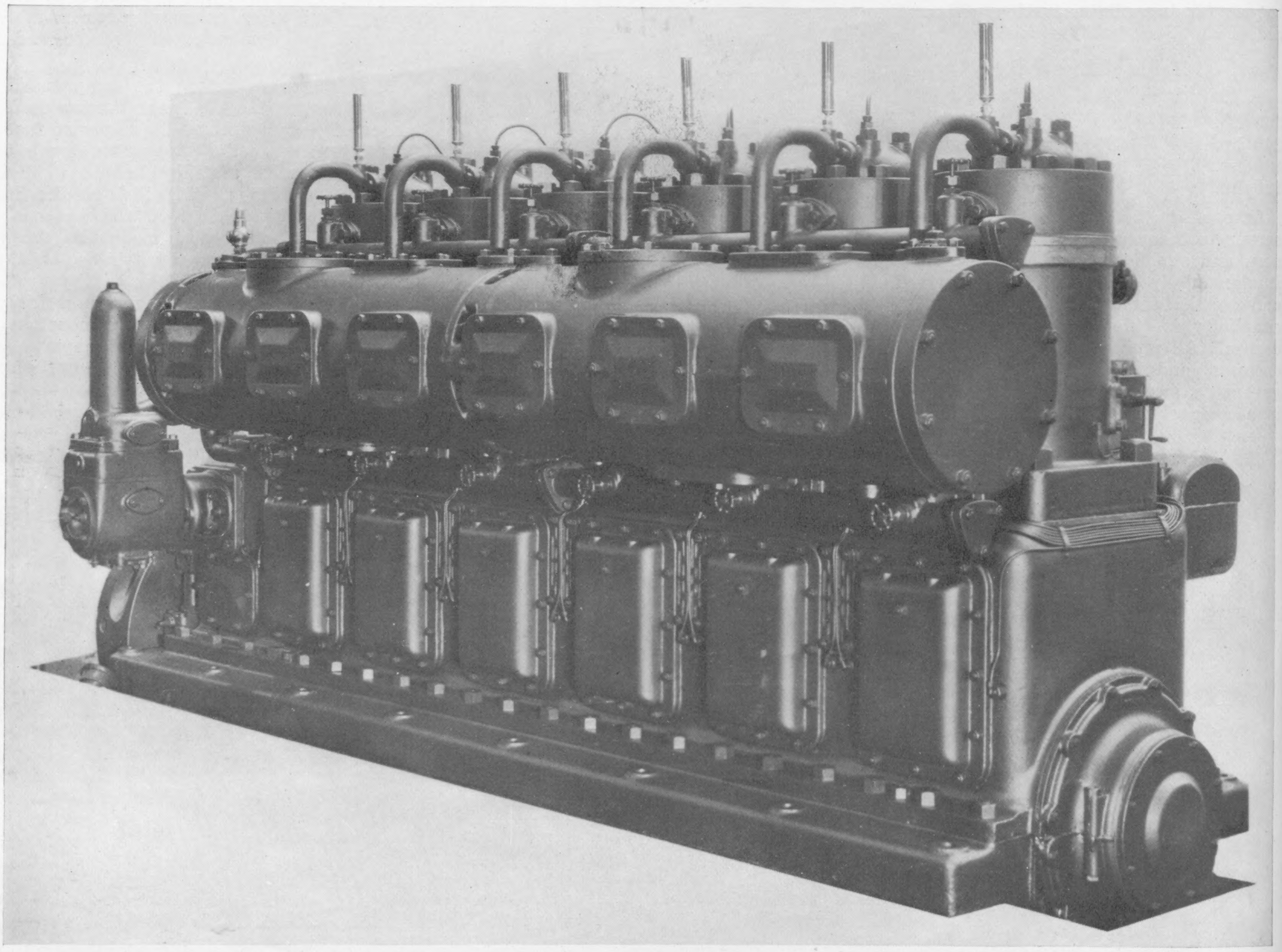
An important advantage of the 2-stage combustion scheme is that its success is not dependent on the use of fine multiple orifices in the fuel injection nozzles or the use of high injection pressures. An interesting feature is the approximate equalization between the velocities of the oil jet and of the air entering through the neck toward the end of compression. It was established that an insufficient velocity did not give the best results because of deficient turbulence and that an excess of velocity had a tendency to throw the fuel back against the cooler portions of the combustion chamber. Careful design and precision in manufacturing methods have made it possible to secure the proper balance between air and jet velocities.

A careful distinction is to be made between the system here used and those precombustion methods which depend upon an actual explosion for projecting a part of a liquid fuel charge into the cylinder.

From the practical operator's point of view, the use of a low velocity fuel oil jet has the important implications that not only are excessive fuel pump pressures avoided, but it is possible to employ unusually large atomizers and injection nozzle diameters. Actually the nozzle diameter is 5/64 in., and the helical stem placed just ahead of the nozzle has course grooves of nearly the same size. A spring-loaded check valve placed inside the body of the nozzle makes for a sharp beginning and ending of the jet. In view of the large passages through it, there would hardly seem to be any occasion for ever taking it out; nevertheless, it is accessibly mounted and can be removed in less than a minute by simply unscrewing it.

Complete control of the engine is centered in a compact and accessible unit located at the center of the engine and housing the injection pumps and air starting and reversing mechanism. A governor unit with its handwheel for speed control is mounted alongside the injection and air starting unit, thus centralizing the complete control system.

By referring to the diagrams of the control unit and the governor, it is possible to appreciate the simplicity of the general control scheme. When the control handwheel for starting the engine is turned, the main air valve is opened by a cam on the control shaft. The compressed air passes through this master valve to a passageway which supplies air to the individual valves for each cylinder. The air starting cams revolve with the camshaft, raising these individual valves and admitting air to each cylinder in the firing order.



Back of the new F. M. engine with water circulation headers above and below the cooled exhaust manifold

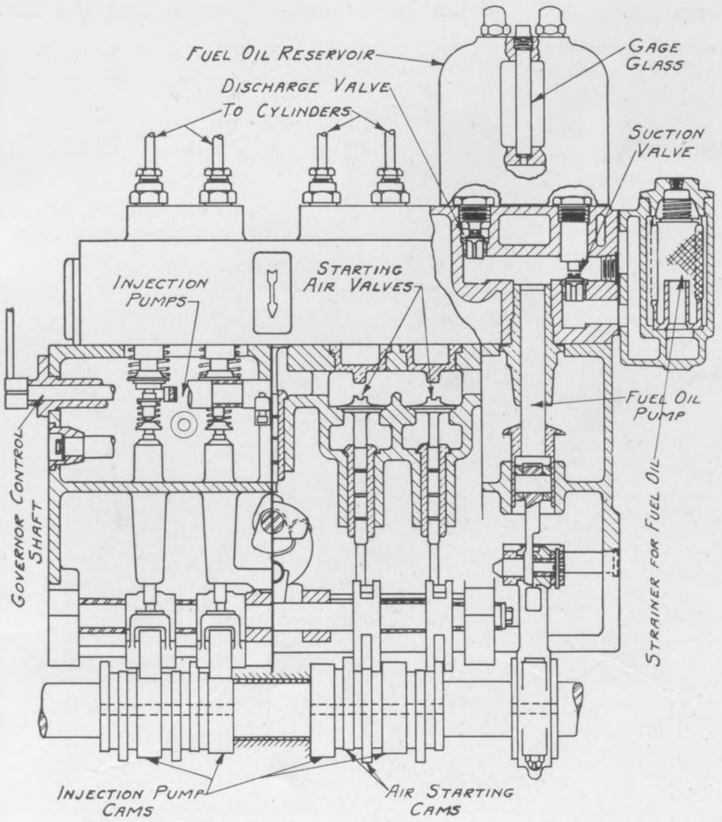
During the admission of compressed air, the fuel control cam turns an arm underneath it, which in turn moves a shaft raising the suction valve rockers so that fuel cannot be injected. When the engine begins to turn over on compressed air, the control wheel is turned back to the running position and the fuel control cam releases the suction valve rockers, the fuel pumps then being enabled to inject fuel to the cylinders and firing commences.

When the control wheel is turned from the start to the "run" position, the main

air valve is closed and a relief valve is opened, allowing the air pressure in the space leading to the master valve to escape to the atmosphere.

It will be noted that the camshaft also carries the cams which operate the fuel injection pumps. As the cam revolves, it raises the injection pump roller which in turn actuates the injection pump plunger. It is not possible, however, for fuel to be injected through the discharge valve to the cylinder until the suction valve has closed. The closing of this suction valve is accomplished by means of a valve rocker actuated by the upward movement of the injection pump plunger. This suction valve rocker is pivoted on a shaft that is turned through a slight angle as the pump plunger moves upward. As the rocker drops, the suction valve closes and the fuel oil is trapped so that its only course is through the discharge valve and to the cylinder.

Since the amount of fuel injection is dependent on the load carried by the engine, the suction valves have to be placed under governor control. The suction valve rocker is pivoted in eccentric bearings and the amount of rotation is determined by the position of the governor weights linked with this shaft as indicated on the sectional view of the governor. When the load on the engine is increasing, the suction valve closes earlier in the stroke of the pump plunger, and thus more fuel is injected.

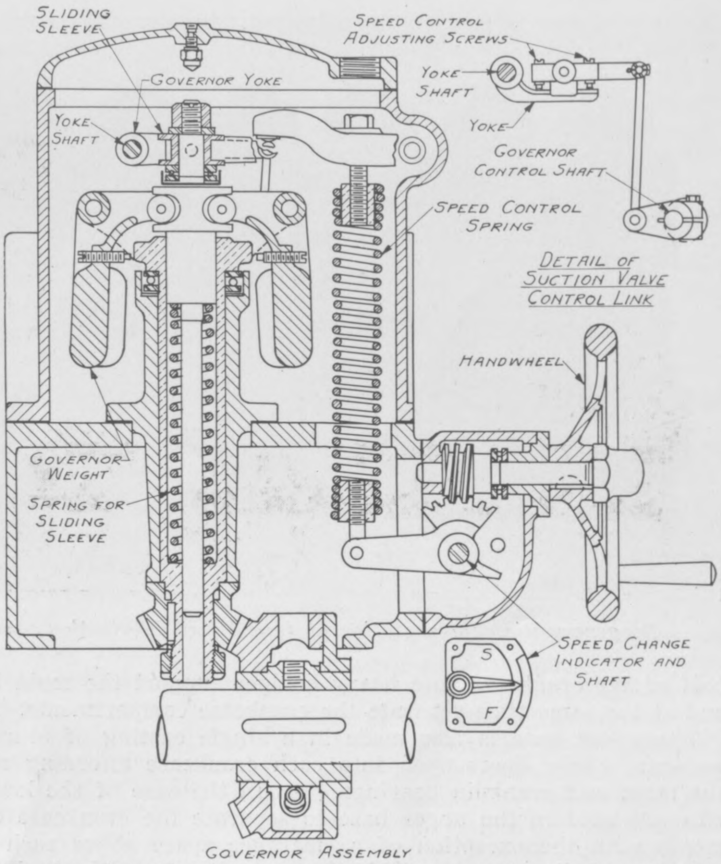


Composite longitudinal section through fuel pump and starting valve unit

For reversing the direction of rotation of the engine, a cam on the engine control shaft actuates a roller pinned to the reverse control arm. This arm in turn moves the air-start rockers and rollers along the shaft until the rollers are directly over the correct cam. When air is then admitted to the individual air-start valves, these push the air-start rockers with their respective rollers down on the cams, and the position of the cams determines which valves remain open to start the engine in the desired direction.

The governor is of the flyball type, having a vertical spindle driven from the camshaft by a flexible drive bevel gear. As the engine speed increases or decreases, the weights swing at a varying radius which causes the sleeve to slide up or down the spindle. The governor yoke is keyed to a shaft which can turn slightly, and the movement of the shaft is transmitted to the fuel pump suction valve rocker shaft as shown in the diagram. The adjusting screws are set for the correct cut-off of fuel at the rated horsepower and speed. Thus the governor controls the amount of fuel injected by regulating the effective length of the injection plunger stroke.

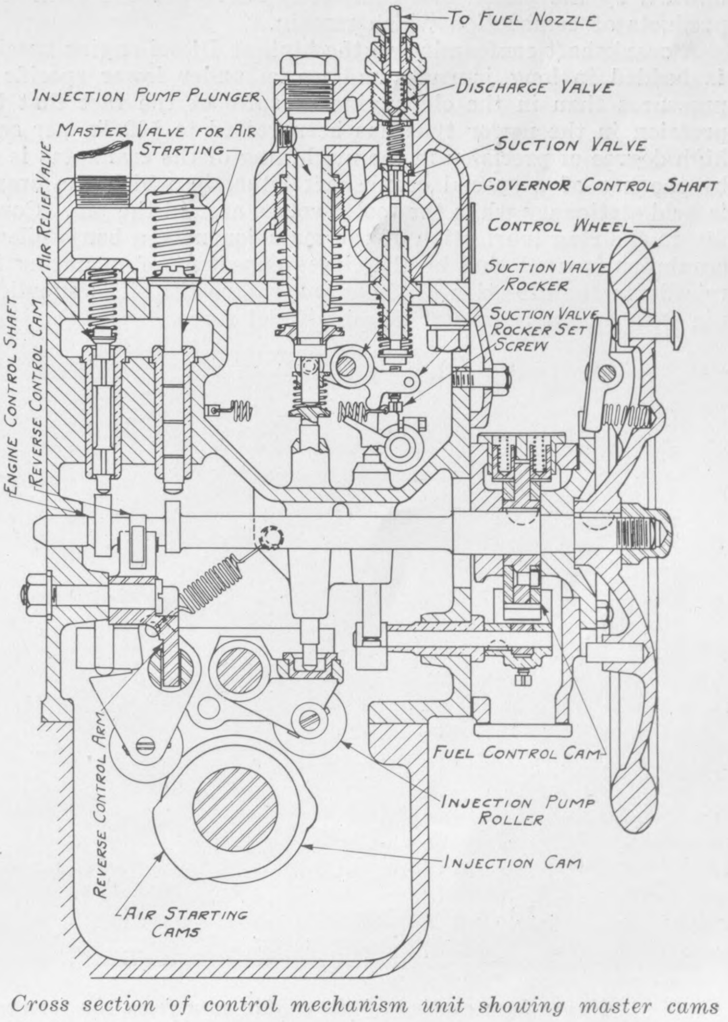
A large range of speed variation can be obtained by turning the speed control wheel. A reduction of speed is obtained by putting tension on the spring, which in turn pulls down the arm to which it is held at the top, and this arm forces down the control rod. The control rod turns the fuel pump suction valve rocker shaft and thus has the same effect as if the governor weights were thrown apart.



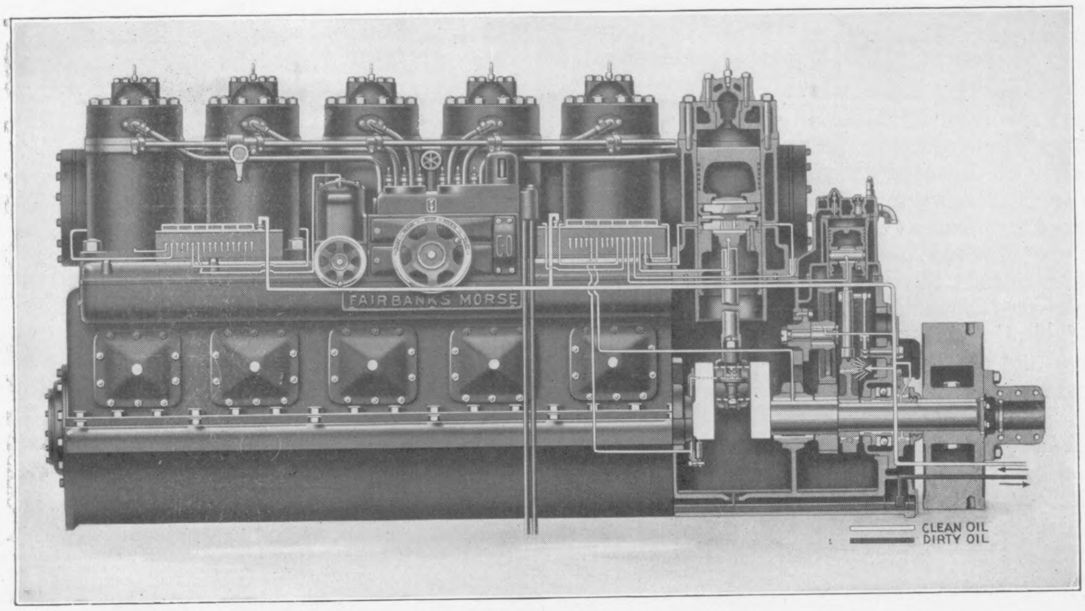
Section through governor unit, showing speed control mechanism

It holds open the fuel pump suction valves for a longer period of the injection stroke and decreases the amount of fuel injected.

On referring to the transverse section one can note that the engine is built up of three main sections, the lower base, the upper base and the individual cylinders. The lower base is a single casting of heavy construction provided with wide box-section flanges on both sides for bolting to the foundation. These flanges are located just below the center line of the shaft. The lower base forms the lower



Cross section of control mechanism unit showing master cams



Diagrammatic representation of forced feed lubrication system in new C-O engine

half of the crankcase, and heavy bridges support the main bearings and at the same time separate the crankcase compartments.

The upper base is also made in a single casting of sturdy cross section. Large doors open into each crankcase affording access to the main and crankpin bearings. As in the case of the lower base, ribs are used in the upper base to separate the crankcase compartments with the exception of a clearance space above each bearing to allow for its removal. This clearance is covered by a sheet metal disc bolted to the bearings and the upper base, making an effective air seal.

A compartment is cast in the exhaust side of the upper base, and this passage runs the full length of it to serve as an air duct for the scavenging air. From this air duct the air is drawn into the crankcase through automatic grid valves as the piston moves upward and creates the suction. When the piston returns on the down stroke and uncovers the air inlet port of the cylinder, this air, which has been trapped in the crankcase, passes through the port, is deflected upward by the piston and completely scavenges the cylinder of any products of combustion which remain.

A crankshaft conforming to the highest Diesel engine specifications is bedded in long journals and works under lower specific bearing pressures than in the old engine in spite of the fact that the compression in the newer type has been raised to 500 lb. per sq. in. A high degree of precision in the machining of the crankpins is obtained by the use of a special crankshaft lathe, in which the crank itself is held stationary while the tool revolves around the pin. Corresponding to the ring lubrication of the main journals, a banjo oiler for the crankpins is used, and by the clever expedient of mounting it eccentrically in the direction of the crank radius the oil is supplied to the pin with an extra amount of centrifugal force.

Both the piston and the cylinder in which it works are cast of a special grade of iron containing approximately 20 per cent of steel and possessed of extra wearing qualities.

Compression relief is arranged for by providing a small valve in each cylinder head. A steel cage is screwed into the cylinder head and contains a spring loaded valve held on its seat by compression in the cylinder during operation. These valves are operated by a layshaft which in turn is manually actuated by a suitable gear.

In this engine the piston has been made of a length characteristic of conservative marine Diesel engine practice, and the ratio of effective length to diameter exceeds 2:1. All longitudinal ribbing is avoided and stiffness is imparted to the piston structure by circumferential webbing only. It has been found that lengthwise ribs sometimes have a tendency to throw the piston barrel out of round, and the fact

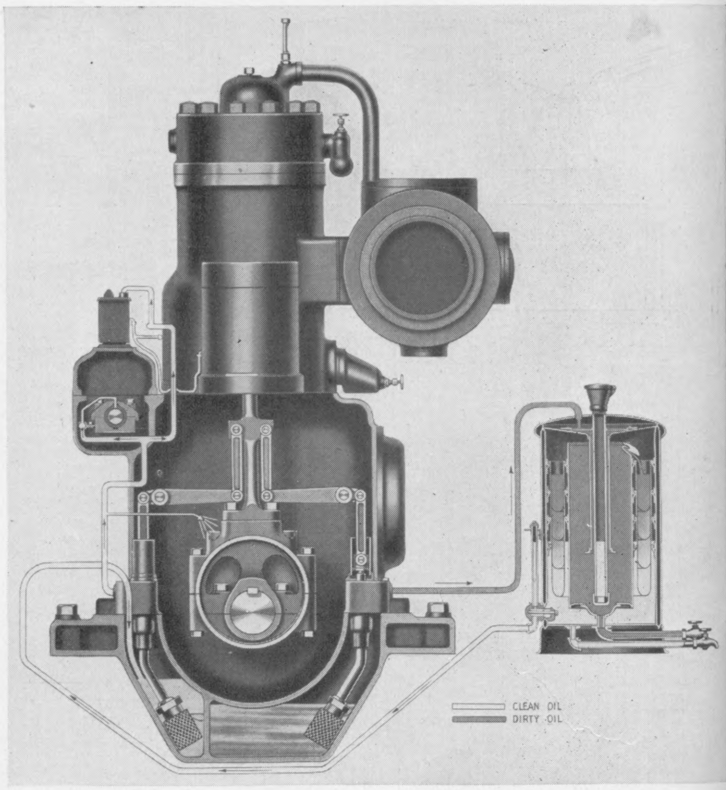
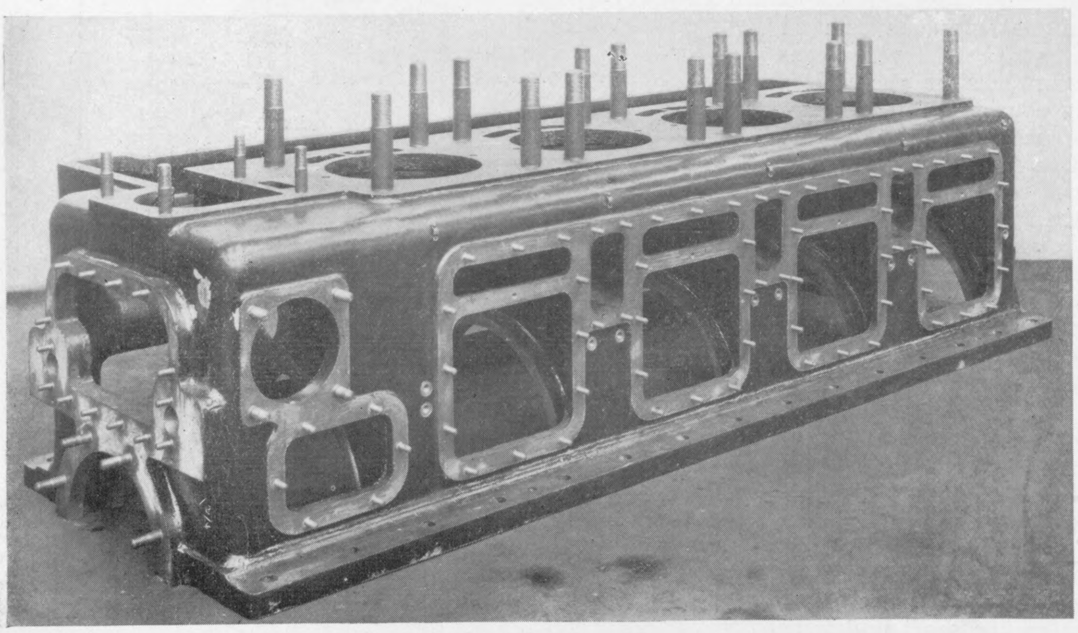


Diagram of oil pumps, filter, feed tank and sump

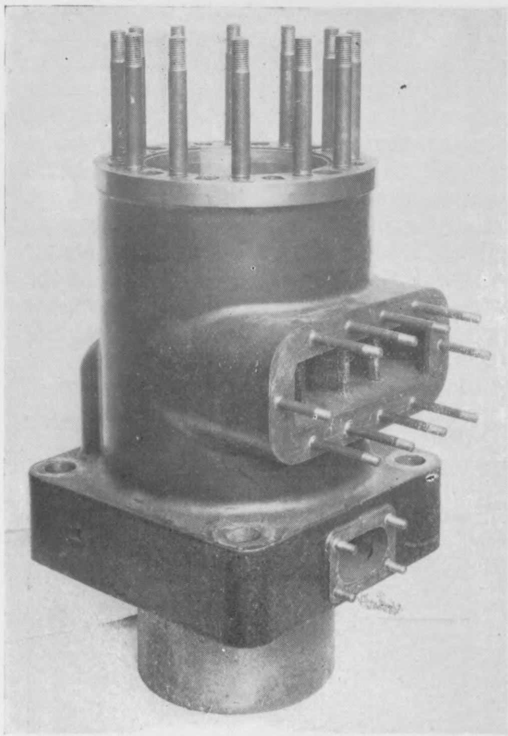
that only circular webs are used is one more indication of the fact that in this design details have been carefully looked after.

One of the most interesting lessons in the design of Diesel engines may be illustrated by reference to the upper end of the piston used in this particular machine. It will be seen that a crown of substantial thickness is used, not so much for the sake of strength as for providing an adequate section for the transmission of heat. It will be noticed also that there is a gradual taper in the thickness of the piston section from the under side of the crown to the interior of the barrel, and the extra metal at this point further carries out the idea of providing for a free flow of the heat.

It has been found that the side surfaces of piston rings are one of the most effective means for getting the heat of the piston away to the walls of the cylinder and thence to the jacket, a consideration which has been borne in mind in providing this engine with six piston rings. They not only



Upper base casting of the engine seen from the forward end at the back

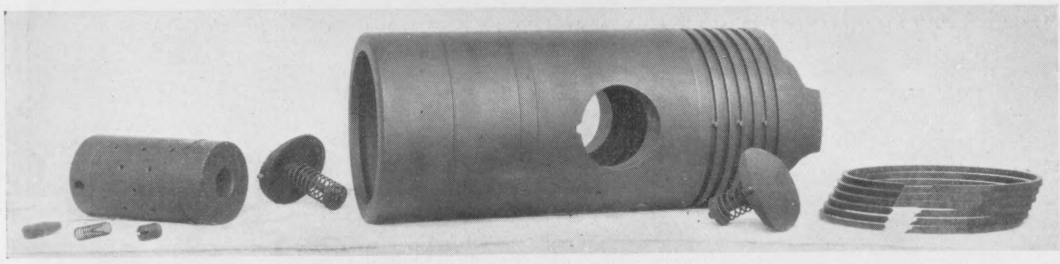


Cylinder casting showing exhaust ports

serve as a means for sealing the compression, but also have an important bearing on the matter of keeping the piston crown cool.

Inside of the piston a deflector is provided for preventing lubricating oil from being splashed against the crown. It amounts hardly to more than a deepening of one of the circumferential webs above the head of the rod, but it is so arranged that it fully intercepts any splash of oil which might otherwise lodge on the under side of the piston crown and carbonize there. It is hardly necessary to point out that, in the absence of provisions of this kind, carbon crusts of considerable thickness are apt to be formed, and when they crack loose and fall down they may interfere with the lubricating system. In some designs this difficulty has been obviated by bolting a cover plate inside the piston above the end of the rod, but it would seem as though the bolted cover would shut off a free circulation of air from underneath the crown and might possibly prevent as effective a cooling of the latter as if it were left exposed to the free circulation of air.

A die-forged connecting rod—one of the largest of this kind manufactured—is fitted with a bronze babbitt-lined crankpin box in two halves and is permanently aligned to the latter by means of a longitudinal key. Straight-shank bolts are used for fastening the box halves together and to the foot of the rod, and as the key takes care of the alignment there is no need for having the bolts body-fitted. Interchangeability in manufacture and replacement is therefore fully preserved. At the piston pin end of the rod a shell bearing is used, insuring against cramping consequent on heat expansion by the fact that it has a saw cut near the top of the shell.



Piston, drilled wristpin, oil retainers and piston rings

During the scraping of both the connecting rod bearings, micrometer fixtures are used for checking the parallelism of the two. In consequence of the delicate measuring apparatus used, it is impossible for the two bearings to be out of parallel either in the vertical or horizontal plane.

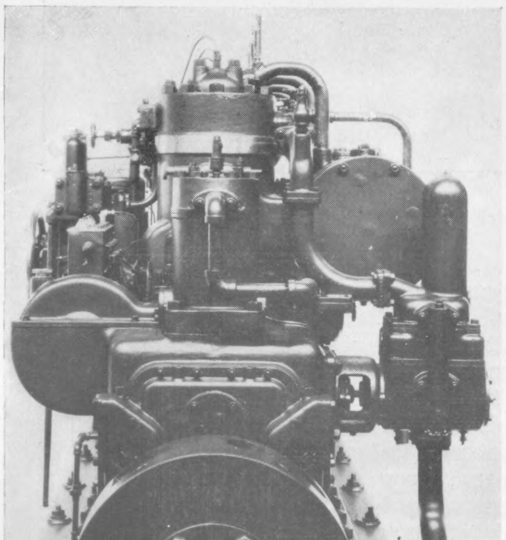
The piston transmits its motion to the connecting rod through a hardened piston pin of large diameter. Here again the amount of bearing surface has been increased so that the pressure is not materially different from that found in the former design.

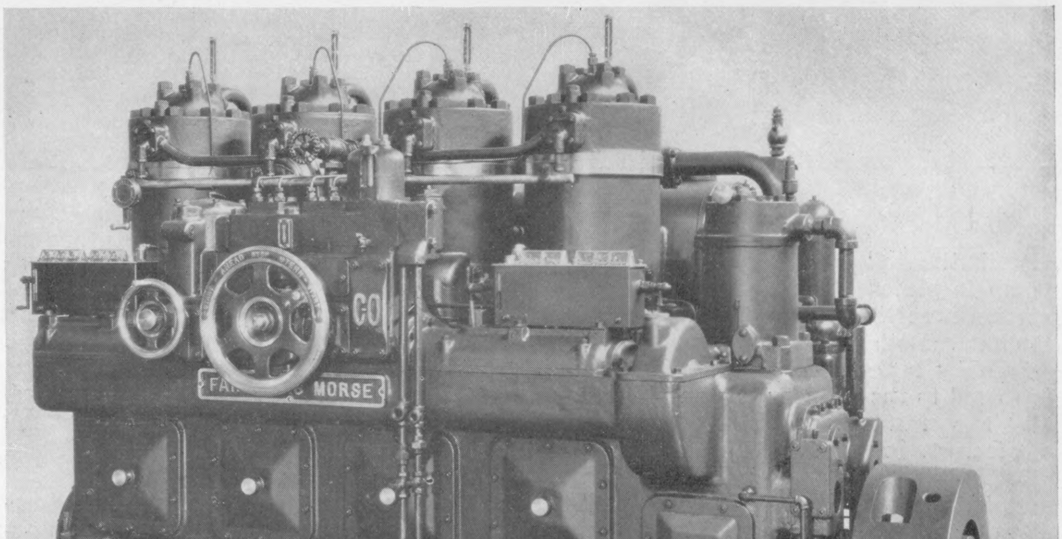
For the supply of lubricating oil to the piston pin a movable side scraper, working in a counterbore of the pin, is used, and at assembly it is carefully bedded to the radius of the cylinder against which it is urged by means of a light spring. A Vee-shaped recess cut into the cylindrical contour of the scraper and terminating in a throat at the base of the Vee-surface is an effective lubricating oil collector. Leading from the counterbore in the end of the piston pin is a steel pipe with a drop nozzle securely brazed into place, a provision which has eliminated the possibility of its loosening or breaking off in service.

One of the features of the piston pin lubricating arrangement is the dependence on a large number of holes through the walls of the hollow pin for the proper distribution of the oil over the bearing surface. The pin, of course, is pack-hardened and ground, but before the hardening process is carried out, the lubricating holes have been countersunk with radii, obviating all sharp edges and providing for the positive formation of the lubricating oil film.

An ordinary taper dowel pin is used for locking the piston pin into the piston bosses, only one of which is a tight fit on the pin. A spring behind the taper dowel insures that it will effectively lock the pin both against rotation and sidewise movement, and at the same time the ends of the spring bear on offsets in the ends of the dowel and of the threaded spring retaining plug in such a way that the possibility of the plug backing out is obviated.

Owing to the fact that possible shocks,





Views of the after end and front of new C-O four cylinder engine, showing compressor and water pump

and a consequent tendency to "work," are not transmitted from the dowel pin by means of the spring the device forms a positive lock.

In order to still further simplify the operation of the engine and to assure the maximum reliability of service, the lubricating system has been made completely automatic. That this has been thoroughly worked out is shown by the fact that there is not a single place in the engine that requires manual lubrication. There are no oil holes or grease cups to be found anywhere on the engine.

At the aft end of the base is a clean oil reservoir in which the suction of the distributing oil pump is set. A similar pump is placed at the other side and its suction is set in the sump at the bottom of the base. Both pumps are identical and are driven by means of arms and links. Oil is forced to the cylinder, piston pin, crankpin and main bearings by force feed lubricators. From these bearings a surplus finds its way to the lower crankcase and is drained to the sump. The dirty oil is then pumped to the oil filter and after being cleaned is fed to the sump chamber for clean oil, from which it is pumped into the lubricator and camshaft oil pipe header.

The camshaft bearings, cams and eccentrics are lubricated by means of the camshaft oil pipe header, to which oil tubes and oil spitters are connected. Clean oil is pumped directly to the oil pipe header by means of the clean oil pump. This same pump also supplies clean oil to the lubricators for distribution. The excess oil pumped to the lubricators overflows into the sump chamber.

In order to warm the oil so that it will filter freely in cold weather the filter is provided with a water jacket which can be piped up to the hot water discharge from the circulating system. The filter is equipped with a 4-section screen which removes any impurities accumulated during the passage of the oil through the engine.

At the aft end of the engine an eccentric drive is provided for the air compressor and the circulating pump. The air compressor is of ample size to meet the usual conditions. It is single-acting with a trunk piston. Spring loaded poppet valves are used at the air inlets, while the discharge valves are of the cup type, spring loaded. An unloading device is located in the cylinder head and operated by pulling a knob to open the suction valve.

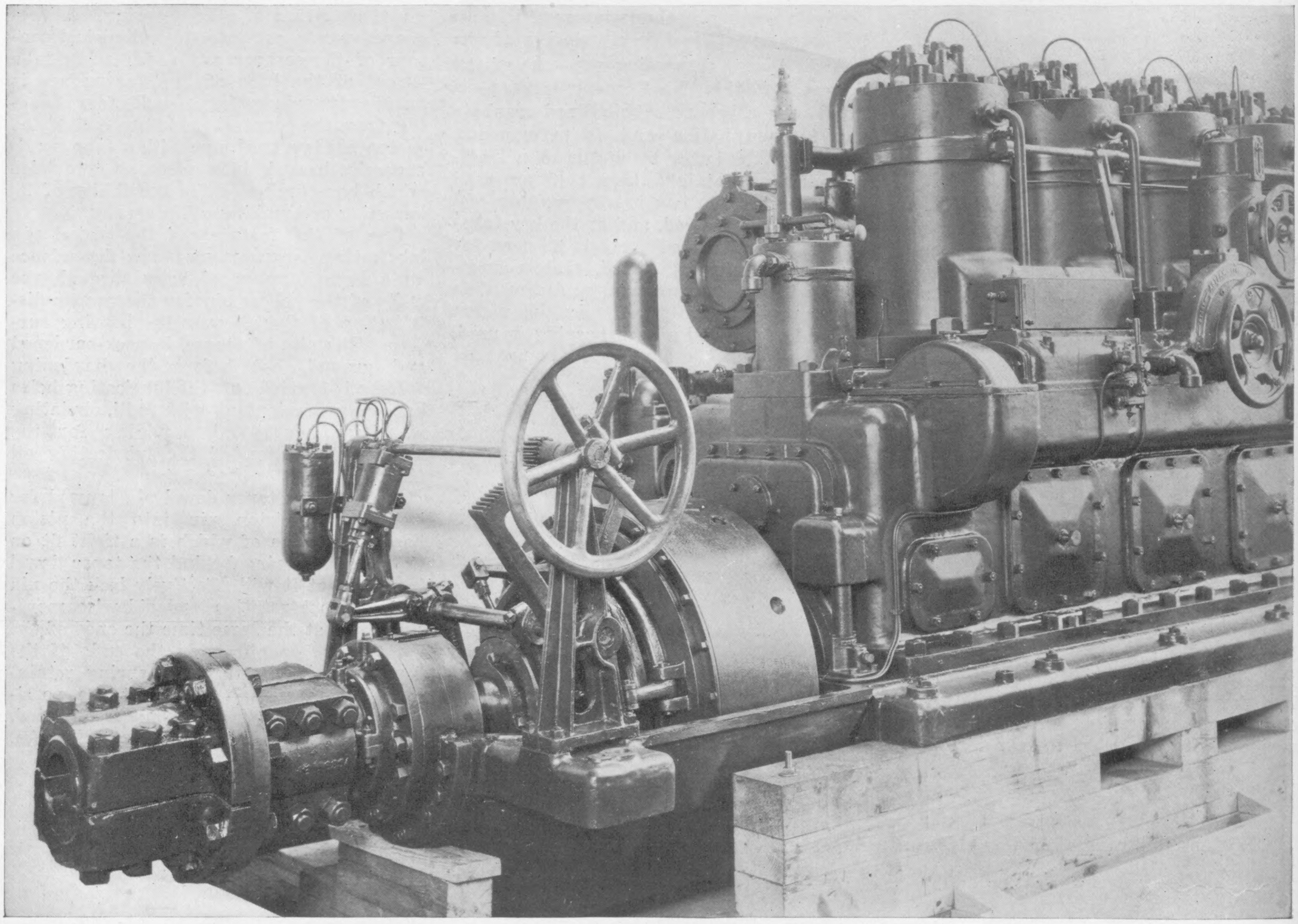
The eccentric sleeve which drives the compressor is lined with babbit and the bearing surfaces are machined on a spherical radius from the center, so that no binding will be caused from shaft expansion. Thus the sleeve can turn on the spherical surface and transmit power at a slight angle.

Simplification of the cooling water connections has been attained by the use of cast iron headers. There are two of these headers, one at the bottom of the cylinder water jackets and the other connected to the cylinder heads. In temperate climates the lower header valves may be throttled down, so that the main circulation takes place in the cylinder head, but in warm climates the lower header valves are partially opened. The lower header is also used as a drain for the cylinder water jackets. From the transverse section of the engine it can be noted that the exhaust manifold is connected with the cooling system.

A large 2-way ball thrust bearing is located on the after end of the crankshaft. This bearing is lubricated under pressure, and an oil throw ring and drain keeps any lubricating oil from creeping along the shaft and being thrown about the engine room.

The camshaft is driven by a train of three solid forged steel spur gears. The drive gear is keyed to the crankshaft and transmits power to the camshaft gear by means of an idler gear running on a hardened and ground steel shaft supported by a cast iron jacket, which in turn is bolted and doweled rigidly to the upper base. Each meshing point of the gear train is lubricated by an oil spray.

Some of these engines have been in service for months, notably in the 720 s.hp. twin-screw tug MAHOE.



Clutch and reverse gear as fitted to the non-reversible models of the new type F. M. engine

Italian Motorship Leme on West Coast

Navigazione Libera Triestina in New Service from Mediterranean Ports to Pacific North America

LEME is a freighter, with limited passenger accommodation, owned by the Navigazione Libera Triestina and operated on a new run from Mediterranean ports to the Pacific Coast of North America via the Panama Canal. The service is to be maintained by two new motorships and two steamers. This company is one of the largest Italian operators of freight vessels, and LEME is its first motorship.

Built as a combined freight and passenger motorship, LEME has only accommodation for 8 passengers now, but provision has been made for the easy addition of accommodation for 40 passengers when desired. She was constructed by the Stabilimento Tecnico Triestino, and the Diesel machinery came from Franco Tosi at Legnano.

LEME measures 450 ft. o.a., 57 ft. breadth, 35 ft. molded depth and 27.2 ft. loaded draft, with a d.w. capacity of 10,800 tons consisting chiefly of 9500 tons of cargo and 1200 tons of fuel in double bottom tanks. The loaded displacement of the vessel is 15,750 tons.

In an engine room of 74 ft. length are installed the twin 4-cycle six-cylinder Tosi Diesels which develop 1250 s.hp. each at 125 r.p.m. and 1300 s.hp. each at 130 r.p.m. These engines have a cylinder bore of about 24¾ in. and about 38⅜ in. stroke. A feature of the Tosi engine is the use of director valves, enabling the two big valves in the cylinder head to be used for both inlet and exhaust purposes. The 3-stage compressor on the forward end of each engine has the 1st stage in the center, the 2nd stage at the lower end and the 3rd stage at the top.

The twin propellers are 4-bladed, of 12 ft. 4 in. diameter and an average pitch of 9 ft. 10 in., the pitch ranging from 9 ft. 3 in. to 10 ft. 4 in. The full speed test gave the vessel a speed of 12½ knots at 130-132 r.p.m. with the vessel drawing 19 ft.

When at sea the auxiliary machinery is Diesel-electric driven, but when in port a steam generating set is used, because steam is kept up in port to operate the steam winches. The donkey boiler is installed at the forward end of the engine room. The pair of two-cylinder 100 b.hp. Tosi engines connected to generators are installed on the port side of the engine room. These develop their power at 180 r.p.m. and the geared up generators, rated 56 kw., turn at 1000 r.p.m. Auxiliary air compressors, bilge and ballast pumps, fuel transfer pumps, circulating water and lubricating oil circulating pumps are driven by electric motors, and there is an electric steering engine. An emergency compressor is steam driven.

The engine room staff of 15 is made up of five engineers, two electricians, one assistant engineer, four mechanics and three oilers. Ernesto Zitco, the chief engineer, is enthusiastic over Diesel power. His previous experience has been in steamers. He says that the reason steam winches were installed in the LEME was that the owners already had the donkey boiler and winches on hand. Electric cargo handling machinery was favored for any further motorships that might be built.

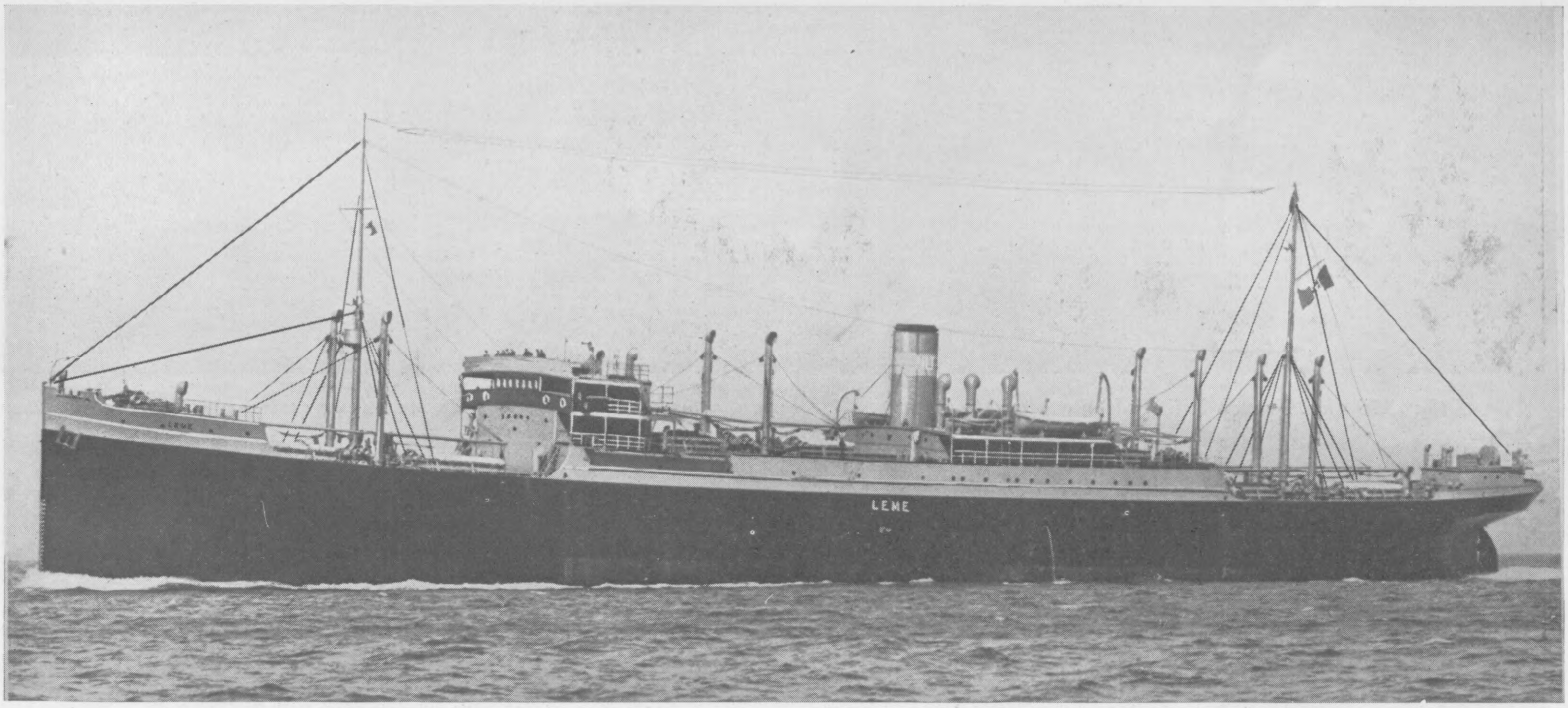
LEME left Trieste on her maiden voyage on Oct. 7 last, and after calling at Mediterranean ports crossed the Atlantic and passed through the Panama Canal. After calling at the principal Pacific Coast ports of the United States she reached the turning point of her voyage at Vancouver, B. C., on Dec. 24. On this 11,000 mile voyage the chief engineer states he did not have half an hour's delay for the engines.

An average of 10½ knots was maintained on a daily fuel consumption of about 9½ tons, the average daily fuel consumption of the main engines being about 9.1 tons and of the auxiliary engine about 1/3 ton. The lubricating oil consumption averaged 400 lb. a day at sea for cylinder lubrication of main and auxiliary Diesel engines and the air compressor; however, about 225 lb. of this is recovered through a De Laval centrifuge and used again in the forced lubrication system for the bearings. There is more of this oil reclaimed than is needed for bearing lubrication, and Mr. Zitco intends having it tested to see if it has lost anything of viscosity or other elements that would affect it for use over again for cylinder lubrication. A Vacuum D.T.E. Extra Heavy lubricating oil is used for the cylinders, and D.T.E. Heavy Medium was used for bearings before the reclaimed oil was utilized for this purpose.

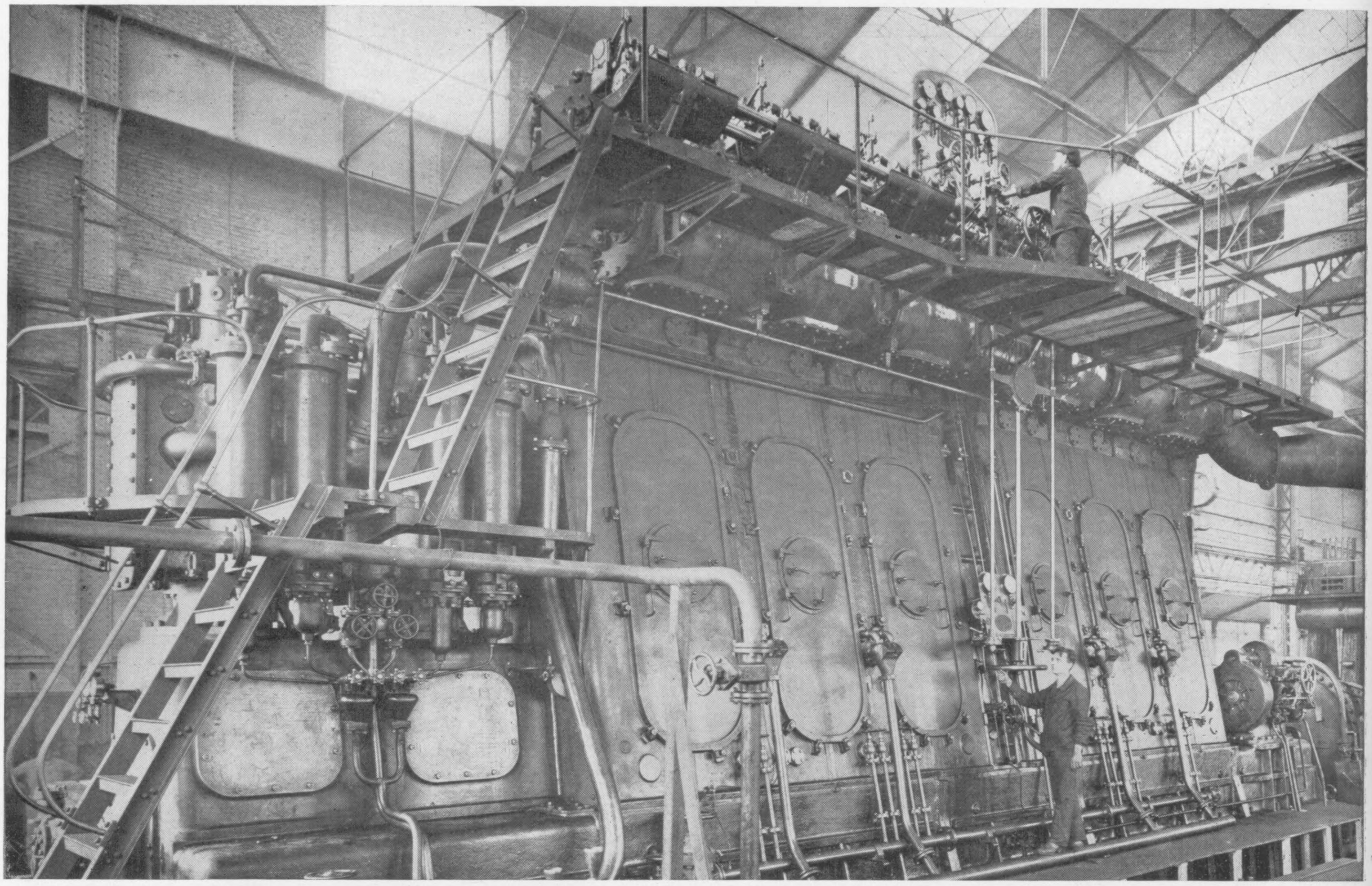
There is another De Laval centrifuge used for purifying fuel oil. The LEME started out with a Shell fuel, grading 34.4 deg. Beaumé, with a flash point of 200 deg. F. and 19,700 B.t.u. On the return voyage she was to fill her tanks with Diesel oil at San Francisco.

The vessel came out in fairly light trim, with 4000 tons of cargo, most of it for Havana and San Francisco. Fairly good weather was experienced. The best day's run was 289 miles on the voyage between Balboa and Los Angeles, an average speed of 11.89 knots, the vessel drawing 18 ft. aft and 13 ft. forward.

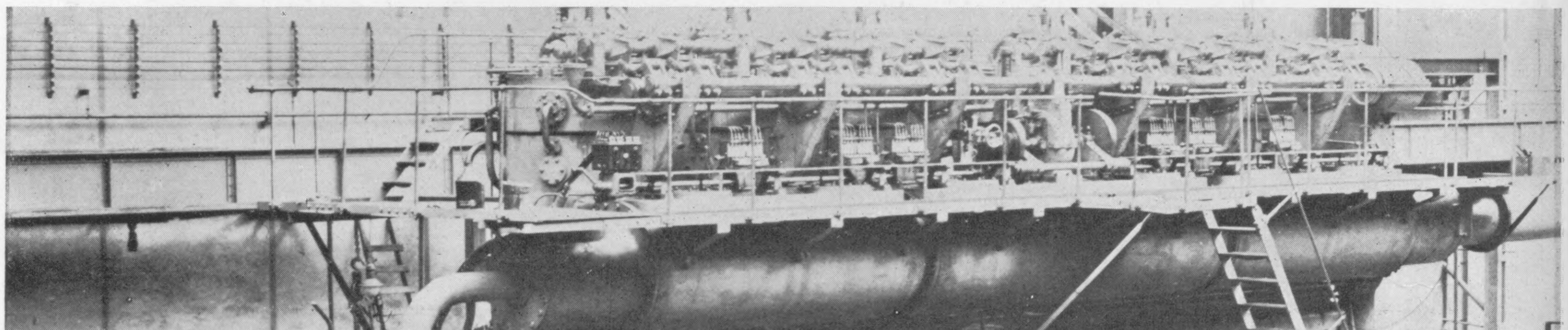
On the return trip LEME is carrying about 9500 tons of cargo, a full load, consisting of wheat, lumber and fish principally, from British Columbia and American Pacific coast ports and all consigned to Italian ports.



Italian motorships are visiting American ports in greater numbers. Above the m.s. Leme, a recent visitor at Pacific Coast ports



One of the 2175 s.hp. French built Sulzer engines (cylinders, 23.62 in. diameter) for the Messageries Maritimes motorship Théophile Gautier



One of the 3600 s.hp. Dutch built Sulzer engines (cylinders, 29.92 in. diameter) for the Rotterdam Lloyd motorliner Indrapoera

Range of High Powered Sulzer Engines

Development of Single-Acting 2-Cycle Type Keeps Abreast of Progress of Other Engine Types

AT the present moment with the wide-spread interest in the application of the Diesel engine to fast passenger liners, fast passenger boats for short runs and fast freight ships, all demanding powerful machinery, it is useful to summarize and review some particulars of the large Sulzer engines, in which the maximum power development of the single-acting type of engine has so far been obtained.

Three sizes of cylinders have been adopted in large Sulzer marine engines, and the powers developed per cylinder at a mean indicated pressure of 90-95 lb. per sq. in. and a piston speed of 750-800 ft. per min. are as follows:—

Characteristics of Large Sulzer Engines

DIMENSIONS	R.P.M.	I.HP.
23.62 in.x41.73 in.	110	475
26.77 in.x47.24 in.	100	625
29.92 in.x52.76 in.	90-95	750

Nearly all Sulzer licensees adhere to these cylinder sizes. The engines built by Fairfield's for the AORANGI had, however, 27½ in. cylinders, while those for the UPWEY GRANGE and now under construction for the two 7000 b.hp. Bibby liners, have cylinders of 28 in. diameter, all with shorter stroke and higher revolutions than the standard Sulzer engines. The power developed per cylinder in all these Fairfield engines is approximately 700 i.hp. Busch Sulzer's at St. Louis are using 30 in. cylinders for the Standard Oil Co. and Shipping Board engines, the stroke in the former case being 42 in. and in the latter 52 in.

Engines of all these standard sizes are actually in service. They can be built with four, six, eight or 10 cylinders per shaft, so that the total i.hp. obtainable from the tried type of Sulzer engines covers this broad range:—

High Powered Sulzer Engines

	4 CYLS.	6 CYLS.	8 CYLS.	10 CYLS.
CYL. DIAM.	I.HP.	I.HP.	I.HP.	I.HP.
23.62 in.	1900	2850	3800	4750
26.77 in.	2500	3750	5000	6250
29.92 in.	3000	4500	6000	7500

Two eight-cylinder engines with 26.77 in. cylinders have been built and tested and will first be tried at sea in the P. C. HOOFT now completing for the Nederland S. V. Mij. That company has also a 10-cylinder engine with the same size cylinders on order for a new vessel, thus facilitating the supply of spares and the familiarizing of the engineering staff with the machinery of the two vessels. The Rotterdam Lloyd is obtaining a vessel of about the same power, but with two eight-cylinder engines having 29.92 in. cylinders instead of 10 cylinders of 26.77 in., and this ship follows the INDRAPOERA which has two six-cylinder engines having the 29.92 in. cylinders.

Shaft horsepower or b.hp. is naturally dependent upon the mechanical efficiency and varies according to the type of engine and the method of driving its auxiliaries. The scavenge air may, for instance, be supplied by pumps direct-driven off the engine or by means of electrically driven or steam-driven turbo blowers, and this correspondingly effects the mechanical efficiency, which is further influenced by the number and size of cylinders, the revolutions and stroke-bore ratio.

The standard Sulzer engines listed above have a mechanical efficiency between 74 per cent and 78 per cent with direct-driven scavenge pumps and between 78 per cent and 82 per cent with turbo blowers, the higher efficiency corresponding in each case with the larger engines and increased number of cylinders. The mechanical efficiency carefully measured in the case of the engines for the P. C. HOOFT was 82 per cent.

Assuming the same efficiency for a 10-cylinder engine with cylinders of 29.92 in., the b.hp. obtainable from this engine, the largest single-acting type yet ordered, would be 10 x 750 x 0.82=6100 b.hp. A twin screw ship of over 12,000 b.hp. can therefore be built with single-acting engines developing no more power per cylinder than has already been obtained at sea.

During the past few months John Brown's of Clydebank have been carrying out exhaustive trials on a 4-cylinder Sulzer type engine which develops approximately 4000 b.hp. at 85 r.p.m. with cylinders of 35.43 in. diameter and about 63 in. stroke. Twin-screw eight-cylinder engines of this type will thus give a total of 16,000 b.hp., which exceeds the power yet obtained with any other engines, either of the single-acting or of the double-acting types.

Whether the supply of scavenge air shall be given by pumps or turbo blowers depends mainly upon the nature of the whole machinery equipment. Unless the auxiliary and deck machinery are electrically driven it is difficult to justify the provision of large auxiliary generating sets solely for the purpose of driving the blowers. Fortunately, it is now becoming the practice to take advantage of the great economy made possible by the use of electric winches and other electrical machinery so that the generating sets required for the deck machinery load in port become available for driving the turbo blowers at sea, thus providing an ideal arrangement which ensures a good load factor to the generating sets.

When steam auxiliaries are used on the ship, requiring a boiler to be kept going at sea, it may be advisable to drive the blowers by means of a steam turbine, but, while this system is absolutely reliable, the fuel consumption will be appreciably greater than with either the electrically driven blowers or direct-driven pumps. With direct pumps or blowers the fuel consumption is between 0.40 lb. and 0.42 lb. per b.hp.-hr., due account being taken of the fuel used in the auxiliary engines for supplying power to the blowers. With steam driven blowers, however, allowing for the fuel used for supplying steam to the blower turbine, the consumption will be between 0.45 lb. and 0.48 lb. per b.hp.-hr.

Injection air compressors are always of the 3-stage type and direct-driven. Their capacity is made sufficient to supply approximately double the quantity of air necessary for injection purposes, the balance being available either as a stand-by supply or for recharging the starting air receivers. Standard Sulzer engines having more than four cylinders are provided with two compressor units as seen in both of the accompanying illustrations.

The most important feature of the Sulzer design is the double row of scavenge ports at the bottom of the cylinder liner, the upper row of ports being controlled by automatic valves which permit a slight supercharge of air to be admitted to the cylinder. Just as with 4-cycle engines using a supercharge, this system ensures good combustion at high mean pressures, reduces cylinder temperatures and exhaust gas temperatures and justifies the adoption of a mean pressure higher than would be suitable for an engine without any supercharge. During trials carried out with the tanker OTOKIA fitted with two four-cylinder Sulzer engines having 23.63 in. cylinders the engines were run continuously for four hours with a mean indicated pressure of 115 lb. per sq. in. and continuously for 44 hours at 100 lb. per sq. in. m.i.p. without any sign of overloading. The load in service will correspond to 90-95 lb. per sq. in. m.i.p.

Sea water is invariably used for cooling the jackets and cylinder covers in Sulzer engines, the water spaces being sufficiently large and accessible to avoid difficulties even if the water is dirty. For piston cooling, where pipes and passages are necessarily more confined, it may be necessary in cases where a ship is frequently navigating in muddy water to provide either fresh water or oil cooling.

The position of the controls can be arranged either on the upper grating at the cylinder level or on the engine room floor, and is generally dependent upon the convenience of attendance to the other machinery in the engine room. In several Sulzer engines the controls have been arranged so that either upper or lower levers can be used, but in practice it has been found that the upper stand is preferred, the lower controls being rarely used.

Generally the bedplate design is arranged for fixing on a built-up engine seating, but in some cases, as for instance in the AORANGI, the bedplate is of the tank-top type.

The above remarks refer to engines of types already in service in merchant ships, but considerable advances have been made also in the development of powerful high-speed engines for submarines. The latest engine of this type built at Winterthur develops 7000 b.hp. at about 290 r.p.m. and represents possibly the highest technical achievement in the manufacture of Diesel engines by the Swiss firm.

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Achievements of American Shipping Revitalized

AN inspiring demonstration of as skilful seamanship and as tenacious courage as the world can ever witness was furnished by the United States liner PRESIDENT ROOSEVELT last month, when in one of the worst storms of the winter North Atlantic she stood watch for three long days and nearly four long nights by a battered and sinking freighter before she finally succeeded in rescuing all hands.

Captain Fried, First Officer Miller and every unknown man who stood his watch on the bridge, on deck or in the engine room during that time of peril to the American liner, when a misunderstood order at the wheel or a delayed order in the engine room might have involved the second ship in disaster have deserved well of their country. They have set a brilliant example to fellow seamen; have thrilled the country as it was never thrilled before by a Government owned liner and have shown the world that American seamanship revitalized can rise again to the heights it attained in the old days of the whalers and clippers.

Throughout the length and breadth of the United States the skilful feat of the PRESIDENT ROOSEVELT has been acclaimed in a manner that will be of lasting benefit to the American Merchant Marine. It has rekindled the patriotic pride in ships. It will ensure a more sympathetic attitude towards the efforts of the Shipping Board to hold our merchant fleet at sea. It may influence Congress to disregard the administration's proposal to starve the Shipping Board on $14,000,000 next year.

It was a triumph of American character and manhood allied to a sound ship and modern equipment. What the PRESIDENT ROOSEVELT did our other ships stand ready to emulate. As we wrote last November—

"An American ship today in a foreign port is respected. We have now only sound ships in the foreign trade, with capable masters and experienced deck officers, manned by seasoned crews that conduct themselves ashore in a way that does not earn us scorn, and propelled by machinery that is dependable and cared for by engineers who know the game. Freight is landed in good condition, and shippers do not have to bother with claims. Ships sail on schedule and arrive on time unless heavy weather delays them. Gear and equipment are well maintained. Efficiency is dominant. Only because of these great changes that have come over our foreign going ships since the fantastic days of 1920 could it have happened that the three S. O. S. calls heard in the North Atlantic in the short space of seven days towards the end of an unusually stormy October were each answered by an American ship in the manner of the best traditions of the sea."

While we do honor to the PRESIDENT ROOSEVELT and take pride in the striking recognition such a seahardy race as the British have given to her great feat, let us again take opportunity to reflect upon the wide national benefit of the great improvement in the operation and management of our foreign trade ships that have made such things possible. The combination of skilled leadership, experienced manning and modern equipment essential to such an achievement as that of the PRESIDENT ROOSEVELT could probably not have been found in one ship during the insane days of 1919 and 1920. Today the combination exists in nearly all our foreign trade vessels, because management is more experienced and wiser. That same management is the mainstay of our hope in the future success of our merchant marine. Such management will find a way out of the present anomalous situation, wherein our shipping is handicapped by the same measures that preserve our standard of living.

Progress on S. B. Conversion Program

INSISTENCE by the Shipping Board upon adherence to the original schedule of engine deliveries for the conversion program would have been injudicious after the evidence presented itself that technical difficulties have been encountered by the engine contractors. Acceding to the requests of the engine builders, the Shipping Board has granted extensions of time. The decision is wise. It means that such modifications of detail as preliminary shop trials show to be desirable will be made at the engine works, which is the proper place to carry them out, instead of in the ship, where they are difficult to take care of, where they upset sailing schedules and where they throw an unfair burden on the engineers.

To carry out its adopted policy of encouraging motorships under the American flag, the Shipping Board was required not only to develop a fleet of motorvessels it could offer to American shipowners on terms comparable to those it gives in the case of steamers, but was confronted by the desirability of assisting the engine industry to obtain the experience indispensable to an American motorship development. Contracts for the engines were entrusted to firms that had not previously built machinery of such power. Some of the builders relied upon their own development; others decided to benefit by European development. All quoted deliveries were predicated upon normal conditions of production, and these expectations have not been realized.

There is no discredit at all in the delays. On the contrary we accept them as testimony that the engine builders are meeting their task conscientiously and the Shipping Board accepting its responsibility with a businesslike understanding. Politicians are beginning to seek whether they can draw advantage from the delays. Honestly they cannot; dishonestly perhaps they can for a time. There is little doubt, however, that at the first sign of attack the whole engine industry would rally to the defence, even those who have none of these first contracts understanding the importance of preserving the way clear and open for the continuation of the Shipping Board's motorship program.

Newest Motorships Have Good Speed

TO assert that the time has come for the Shipping Board to seek authorization from Congress for the construction of fast motorfreighters like the British are now building does not imply that all motorships of lesser speed are obsolete or useless. The British have only a few of them yet and must use up their slower ships. We should, however, no longer delay. A round dozen of motorvessels with better than 14 knots speed are being built by British companies for the accommodation of American trade and commerce with the Far East. When progressive British shipowners discern that our business with the Far East can best be served by the speed and economy of those ultra-modern vessels it behooves the Shipping Board to advise Congress that we cannot expect to get our share of the carrying without ships of equal ability. Secretary Hoover knows it; the Merchant Marine Conference in Washington acknowledged it; the Shipping Board itself is probably convinced. A little action is needed, and if the Shipping Board will solicit the aid of the Department of Commerce to present the case clearly and forcefully to Congress there is no doubt that Congress would authorize the use of money from the Construction Loan Fund for the building of a half dozen vessels of this type to hold a position for ourselves in the services between the United States and the Far East.

Airless Injection versus Solid Injection

MANY years ago this magazine introduced the term "airless injection" to describe what others were beginning to call "solid injection" or "mechanical injection." For the last three years we have used it to the exclusion of every alternative, because it seemed more adequately descriptive and for that reason preferable. The Marine Oil Engine Trials Committee in Great Britain has now accepted the same view. In its third report the term "airless injection" is used throughout, and at the discussion on the report the principal speakers specifically commended the use of the term. This will help further to establish it in the marine world.

World's Most Powerful Diesel Engine

Double-Acting Set Rated at 15,000 hp. Is Completed by One of the Leading German Firms

WITH the erection of the 15,000 hp. double-acting 2-cycle M. A. N. type Diesel engine at the Blohm & Voss shipyard at Hamburg, a new record of engine power has been made. This big set, although built in a shipyard, is not for marine work. It is, however, of a type of which over 60,000 hp. is on order with various M. A. N. licensees, including the New London Ship & Engine Co. and the Hooven, Owens, Rentschler Co., both of whom are building a 3000 s.hp. set.

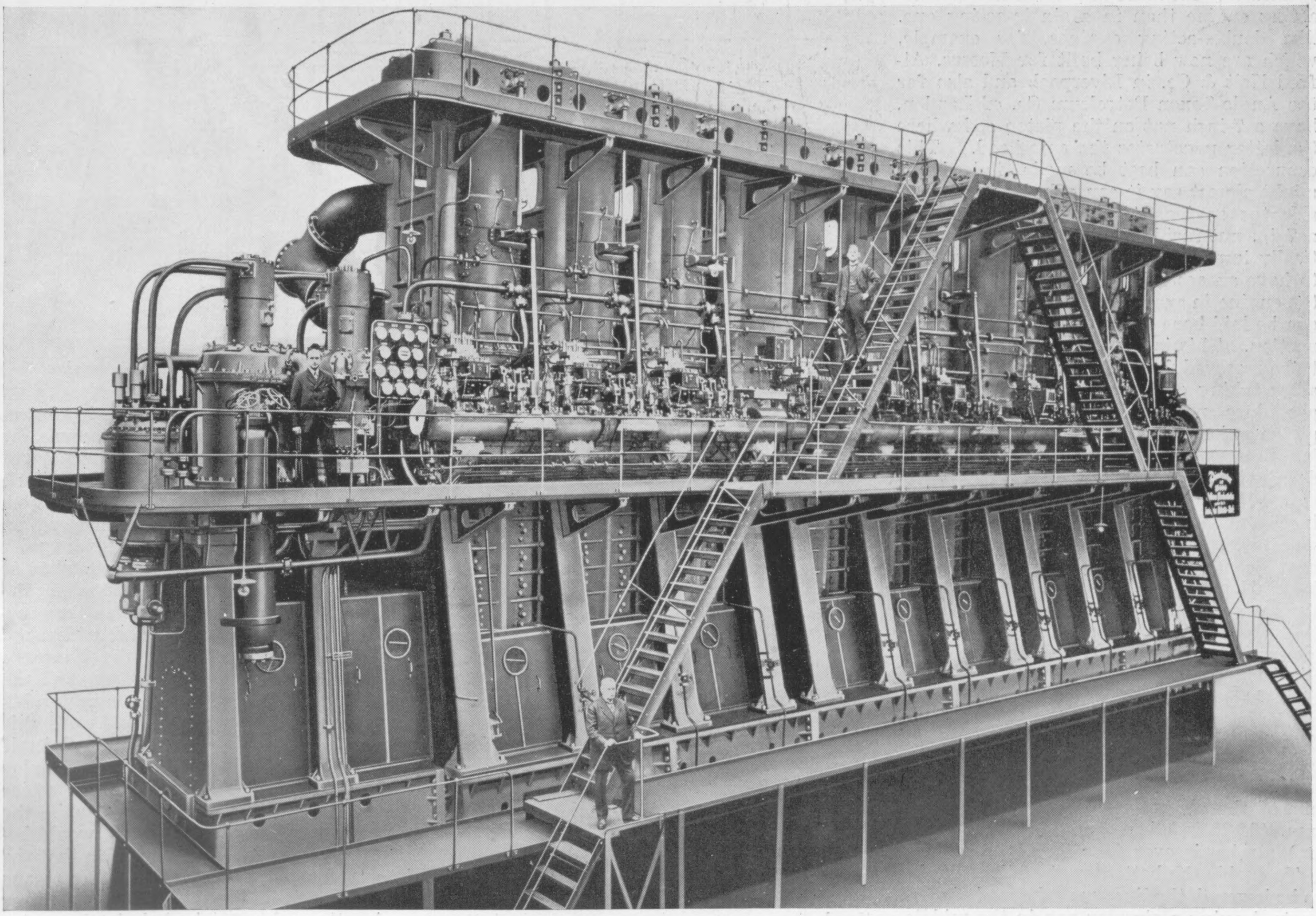
Four sets of this type, aggregating 28,000 hp. are scheduled to go into the large passenger liner AUGUSTUS now building for the N. G. I. at the Cantieri Officine Savoia, Leghorn, Italy. A 4000 i.hp. engine of similar type was recently sent to sea in the motorship MAGDEBURG, built by Blohm & Voss for the Deutsch Australische D. S. Ges. of Hamburg, and prior thereto a 1500 s.hp. engine of this type started her sea service in the FRIDA HORN. The 6-cylinder M. A. N. double-acting engine of the MAGDEBURG is rated at 4000 s.hp. in six cylinders of 29.13 in. diameter and 47.24 in stroke at 75 r.p.m., but 7000 hp. is reported to have been actually developed on test, and the 4000 hp. rating is to be regarded as conservative.

The 15,000 hp. M. A. N. Blohm & Voss engine, the erection of which has just been completed, will now be torn down and reerected in the Neuhof plant of the Hamburg Electric Company, where it will drive a 13,000 kw. generator. Because of the enormous size of the unit, no regular tests beyond checking cylinder compression could yet be undertaken.

Some conception of its size may be obtained by reference to the accompanying illustration, taken just before the engine dismantling was begun in the Blohm & Voss shops. There are nine cylinders of 33.86 in. diameter and 59.95 in. stroke, and the engine turns at 95 r.p.m. By way of comparison, it is interesting to recall the characteristics of the GRIPSHOLM 4-cycle double-acting engines, viz., 33.07 in. x 59.05 in. with a speed of 125 r.p.m. Per cylinder the Burmeister & Wain engines develop 1125 s.hp. as against 1667 of the M. A. N. Blohm & Voss machine.

The length of the engine up to the generator flange is 76.7 ft., while the breadth is 14 ft. 1 in. Including the valves on the cylinder cover the total engine height is 36 ft. 1 in. and from the shaft centerline 32 ft. 10 in. The crankshaft journals have a diameter of 25⅝ in. and the entire shaft weight is 126 long tons. It is built up of three parts.

Scavenging is accomplished only through ports in the cylinder walls, according to a new method devised by the M. A. N. company for its new double-acting 2-cycle design. In this arrangement there are in the upper, as well as in the lower, half of the cylinder walls two rows of ports extending for about half the circumference. At the end of the expansion stroke the piston opens the first row of ports and the exhaust gases pass through them until their pressure falls to atmospheric. Thereupon the second row of ports is opened and the scavenging air admitted. On account of the special form of the ports the air is directed across the piston crown, then ascends at the opposite wall, returning by way of the cylinder head and wall to the exhaust ports. The air really drives the burnt gases before it, and there is not much mixing of gases and air. As the result of this an air excess of about 25-30 per cent above the cylinder volume is sufficient to effect a good scavenging, even with a small scavenging pressure of only about 2 lb. per sq. in. Power required for scavenging has been reduced to about 875 hp., this being about the capacity of the turbo-blower used.



Double-acting engine of 15,000 s.hp., 2-cycle type with nine cylinders, to turn at 95 r.p.m., for power station in Hamburg

Novel Details in Werkspoor D.-A. Engine

Cylinder Construction and Valve Arrangement of the 4000 s.hp. Werkspoor Engines Are Striking Features

By G. J. Lugt*

A description of the single cylinder double-acting engine and its leading details of design developed by Werkspoor in conjunction with the North Eastern Marine Engineering Co., was published in MOTORSHIP *of Aug.*, 1924. *Mr. Lugt has now described an entirely new valve design and explained other features in more detail in a paper he read last month before the Institution of Engineers and Shipbuilders in Scotland.*

ONE of the principal features of the Werkspoor single-acting engine is the piston dismounting device, which enables the engineer to inspect and overhaul the pistons in a couple of hours, and to do this without much trouble. In a single-acting engine, the cylinder being open at the bottom, the pistons can be examined very easily, and the necessity of closer inspection or overhaul can be easily judged. This is not so in a double-acting engine, and it has been deemed essential to provide means not only for judging the working of the pistons while the engine is running, but also for inspecting them without having to dismantle the important parts of the engine, which are better kept in place. This applies, in the first place, to the connection of the piston rod and the crosshead, which is naturally far more important in a double-acting engine than in a single-acting one. The double-acting engines, for example, which are now being built for Messrs. Alfred Holt & Co. in Liverpool, and also for the Anglo-Saxon Petroleum Co. of London, have a 7-inch nut on the piston rod where the latter penetrates the crosshead. This connection can best be made, indeed one might almost say it can only be made, outside the engine. To bring home properly a 7 in. nut inside the crankcasing is practically impossible; the only way, therefore, to have an accessible piston is to construct the engine in such a manner that the piston can be laid bare without breaking this connection. This is impossible if the piston is to be removed from the cylinder at the top, after taking off the cylinder head, as this procedure necessarily entails taking the piston rod out of the crosshead. By lowering, however, the bottom part of the cylinder in its entirety, the piston can be uncovered without breaking any connection in the moving parts, fig. 1. After a few pipe connections and part of the valve gear have been disconnected, and the bolts have been taken out of the flange connection of the bottom cylinder and the cylinder beam, the whole of the bottom cylinder can be lowered in a very short time by means of the turning engine, after putting a distance piece between the stuffing-box and the top of the crosshead. No lifting tackle of any description is necessary, which means a great simplification, considering that the weight of the piston and the piston rod of one of the above-named engines, with 820 mm. (32.28 in.) bore and 1500 mm. (59.06 in.) stroke, is over four tons.

To enable the bottom part of the cylinder to be lowered, the liner must be made in two parts, leaving a circular gap in the middle. This gap is so dimensioned that it practically closes up when the engine is warm, and it causes no trouble whatever. That this is so, also in the long run, is sufficiently proved by the Werkspoor single-acting engines, which have, as described above, a detachable extension for the purpose of piston dismantling.

It will be noticed from the cross-section of the double-acting engine, fig. 3, that it resembles very closely the single-acting engine, with the one difference that the bottom has been closed up and provided with a separate combustion chamber quite outside the circumference of the cylinder, in which all the necessary valves are arranged. The exhaust valve and air-inlet valves are placed vertically on the same center line, the former being on the top, so that it can be easily withdrawn for inspection, and also in order to get a simple connection to the exhaust pipe, which serves both for the top and for the bottom cylinders. The clearance between the piston and the bottom cover is made as small as permissible; the air in the bottom cylinder is, therefore, compressed almost entirely in the combustion chamber, which is only connected to the cylinder itself by a comparatively narrow throat. The fuel valve is placed in the cover at an angle of 45 deg. pointing downward; it injects the oil horizontally in the center line of the combustion chamber. This position of the fuel needle-valve obviates all difficulties with pulverization which are so frequently encountered with inverted and even with horizontal fuel valves.

The size of the combustion chamber is more or less determined by the size and the arrangement of the valves, which require a certain definite diameter, and the final compression pressure comes out lower in the bottom compression space than at the top. This may be considered a disadvantage from the thermo-dynamical point of view, but it is decidedly an advantage where the reliable working of the bottom cylinder is concerned, as also from some other points of view. The compression pressure in the bottom space is about 300 lb. per sq. in. in the engines which are now being built; the scantlings of the bottom, however, are made to withstand a maximum pressure of 500 lb. per sq. in., and the time of fuel injection is adjusted to give a card of the shape illustrated in fig. 2, which is very much like a gas-engine diagram. After the maximum pressure is reached, the expansion follows almost immediately; the combustion takes place practically entirely while the piston is passing over its bottom dead center.

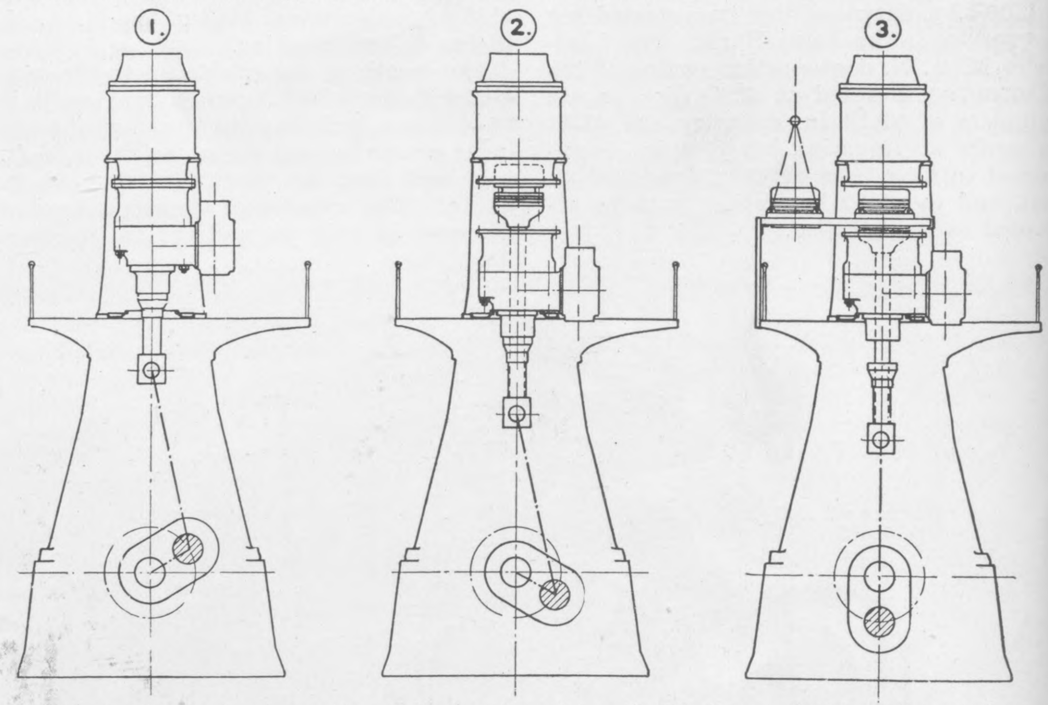


Fig. 1. Means for inspecting and removing pistons in Werkspoor double-acting engine

Particular care has been taken to protect the stuffing-box against high pressure, by increasing the diameter of the top part of the piston rod which enters with a little clearance into a chamber in the bottom cover, forming a kind of differential piston in the cylinder, see fig. 3. The part with the larger diameter leaves the chamber at about 8 per cent of the stroke when the combustion is well over, and when the pressure in the cylinder has fallen considerably. The wire-drawing effect in the clearance has a cooling effect on the gases, and the pressure in the chamber is considerably lower than in the cylinder itself. All this coöperates in keeping the piston rod itself remarkably cool without having to employ a means for cooling it. It is indeed cooler than anyone, who has not felt it while the engine is working at full power, would believe. Incidentally, I may mention that the piston rod is provided with no other means of cooling than the piston-cooling water passing through a $2\frac{1}{2}$-in. hole in the center of the piston rod.

*Chief Engineer of Werkspoor, Amsterdam, Holland.

This, in addition to the fact that the mean indicated pressure in the bottom cylinder is about from two-thirds to three-quarters of that allowed in the top cylinder, tends to keep the stuffing-box in good condition. The experimental engine has now made very nearly 20,000,000 revolutions since it was first started, and there never has been any trouble experienced with the stuffing boxes, in the construction of which nothing new was attempted. They are simply of a type which had proved to be successful in double-acting gas engine practice, where the conditions are almost identical to those prevailing in the stuffing-boxes of the double-acting Diesel engine.

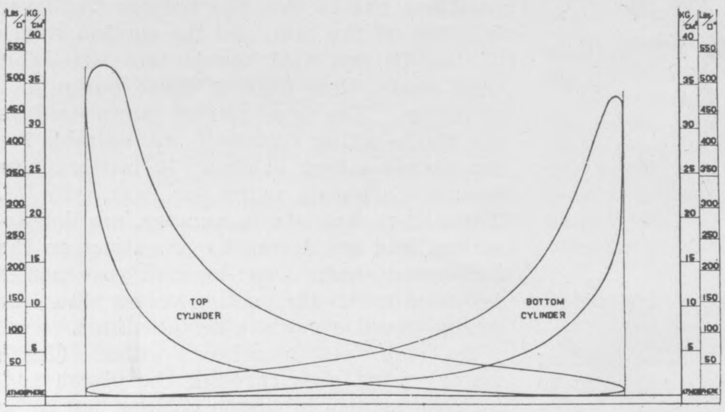


Fig. 2. Indicator diagrams of top and bottom ends of cylinder

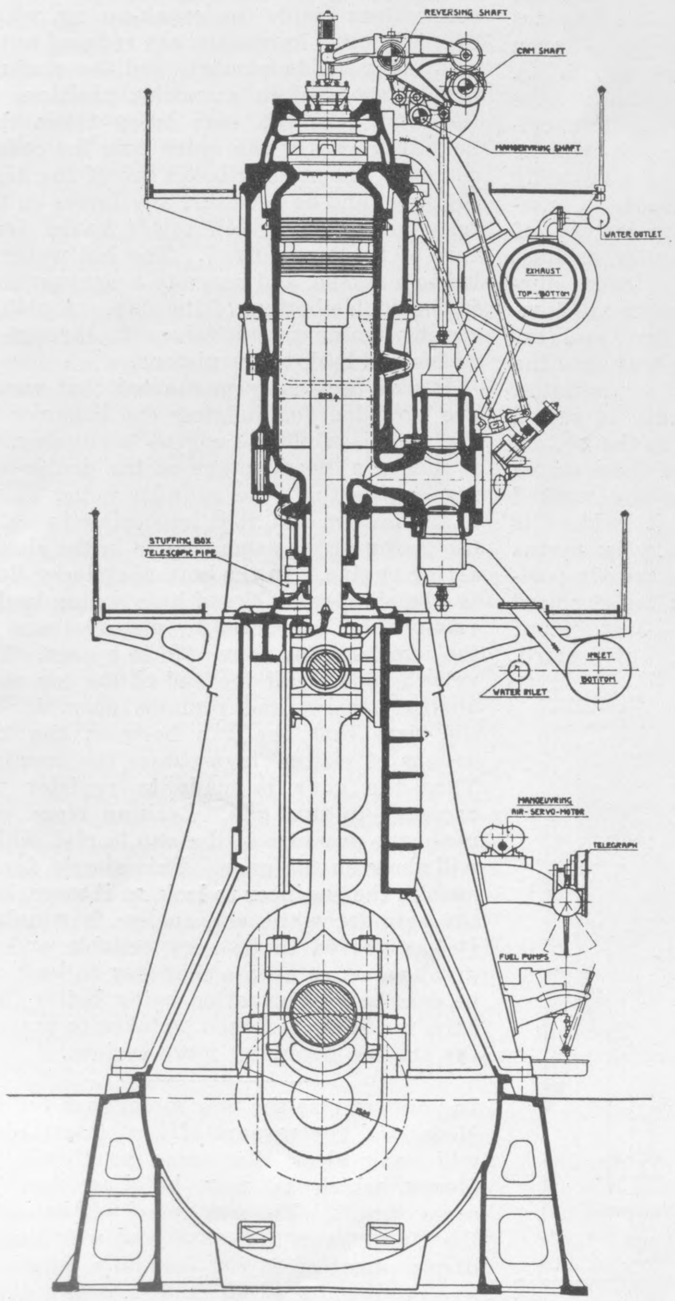


Fig. 3. Section through new type Werkspoor double-acting engine

The valve gear of the double-acting engine is very similar in design to that used on the single-acting engine. The camshaft, which is driven in the same way as previously described, is placed at the level of the top cylinder cover, and it carries the cams for the valves in both the top and the bottom cylinder covers, the latter being driven by means of push rods and intermediate rocking levers. For the fuel valve, a compensating gear had to be devised in order to deal with the extension and deformation caused by heat. The reversing system used on the single-acting engine, however, was not suitable for the double-acting engine, and it was replaced by a system with a sliding camshaft.

As already mentioned, in coöperation with our British licensees, 12 engines of the double-acting type are under construction for the Anglo-Saxon Petroleum Co. of London. These are of the size previously referred to, and, on the whole, are based on the design of the single-cylinder experimental engine which proved so entirely successful during a non-stop run of more than 20 days in May of last year. They possess, however, some novel features which were devised in collaboration with C. Zulver, the marine superintendent of the Anglo-Saxon Petroleum Co., and merit description.

There are few ships that have as little time for overhaul, inspection, or repair as tankers. The average actual working time of the engines in a tanker is about 6,500 hours per annum, and even in port repair work on board is often prohibited, owing to the danger caused by open fires when handling low-flash oil cargoes. Taking into consideration the exceptionally large size of the cylinders, the design of the cylinder heads was simplified as much as possible. It is of a quite symmetrical shape, and with only one opening in the middle for accommodating the necessary valves. This opening had to be, of course, of the smallest possible diameter, fig. 4. As, in an ordinary cylinder cover of a 4-cycle engine, there is hardly room enough for the four valves, namely, the inlet, the exhaust, the fuel, and the starting valve, this necessarily led to combining the inlet and the exhaust valves, and in order also to avoid the use of a large-sized mushroom-type of valve a valve casing with the fuel valve in the center and six small valves surrounding it was developed. The increased number of valves would seem at first to add complication, but everyone knows that small valves, especially if cooled and run at a very low speed as these are, never give any trouble. This valve casing, fig. 5, is comparatively light, has a seat diameter of only 60 per cent of the cylinder bore, and can be very easily removed and replaced if necessary. A spare is carried for each valve casing, just as is usual for the ordinary exhaust-valve cages. From each valve a separate conduit leads to a cone-shaped seat on the valve casing. The latter is surrounded by an oscillating sleeve, in which 12 apertures are made, six leading horizontally to the exhaust belt, and the other six vertically to the inlet belt, fig. 6. The sleeve is moved by an eccentric on the camshaft, and this motion brings alternatively the exhaust belt and the inlet belt into communication with the ports in the valve cage. A suitable labyrinth packing is provided between the two belts. The valve cage is, of course, cooled, but cooling is not provided in the sleeve.

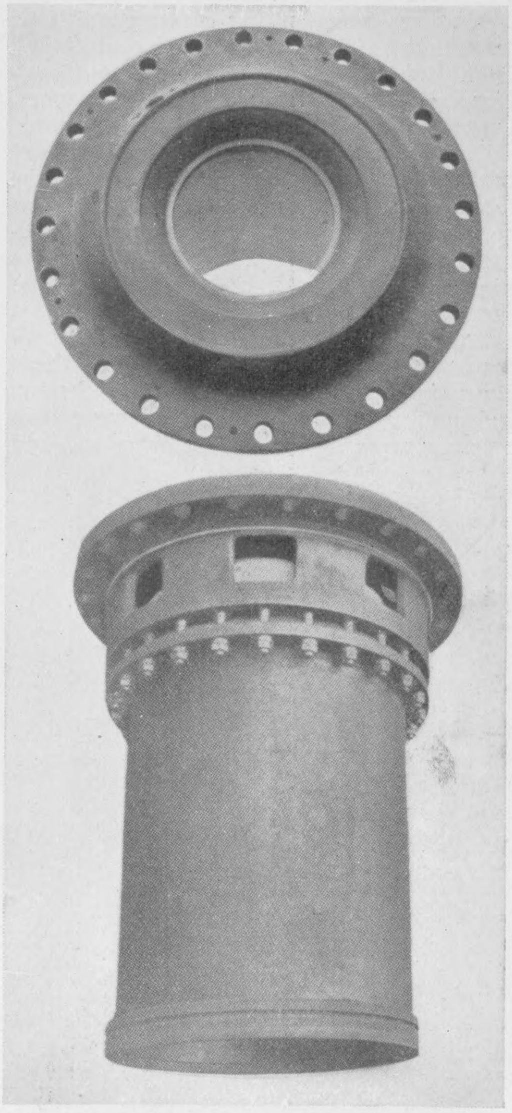


Fig. 4. Cylinder head and upper liner

As this was a radical departure from standard practice, it was deemed necessary to try the system out before applying it to a large number of cylinders. Accordingly a cylinder head of the new design was fitted to the experimental engine, which was run for a considerable time with the new device under conditions as nearly as possible approaching sea-going conditions. It ran consecutively for 82 days, perhaps the longest trial ever made with an experimental engine, and during that time the whole of the gear gave entire satisfaction. It was assumed that the engine was propelling a ship, and the daily distance, calculated from the number of revolutions, was marked on a chart. The total distance amounted to about 26,000 miles, representing a complete tour around the globe, the assumed route being from London to Curaçoa, Panama Canal, Honolulu, Yokohama, Shanghai, Singapore, Colombo, Suez Canal, and back to London.

On opening up the engine after this long run, both the sleeve and the seat were found in excellent condition, and there was no abnormal wear and tear. When the eccentric rod was uncoupled directly after the engine was stopped, the sleeve could be easily moved by hand.

The fact must not be overlooked that all the important parts of an engine of these dimensions and power are fairly heavy, and in carrying out any repair it very soon becomes necessary to call in shore aid and

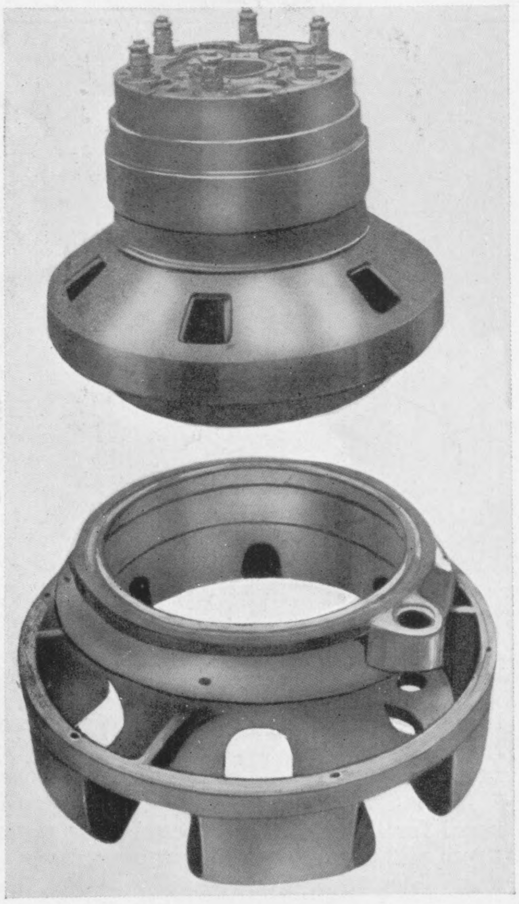


Fig. 5. Valve casing and oscillating sleeve

the assistance of cranes, help which, as a rule, is not available in the oil bunkering ports, and to obtain which the ship might have to go far out of its course.

As mentioned before, the compression pressure on the bottom side of the piston is only 300 lb. per sq. in., and with this pressure self-ignition can not be expected. When the engine is running, however, and only the top cylinders are firing, conditions are

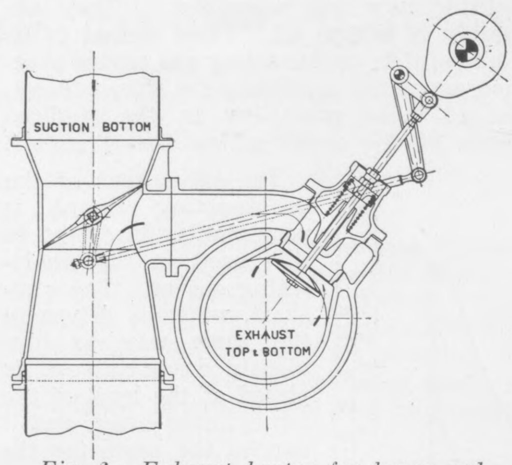


Fig. 6. Exhaust heater for lower end

entirely changed, and only a little heating up of the bottom cylinders is sufficient to raise the final compression temperature to that point where self-ignition will easily take place. The method used for heating up the bottom cylinders on the engines which are being built for the Anglo-Saxon Petroleum Co. is quite simple, fig. 6. A valve is placed between the exhaust pipe and the inlet-air pipe of the bottom cylinders. Before putting the bottom cylinder on fuel this valve is opened, and a butterfly valve in the inlet pipe is closed. Consequently the bottom cylinders, instead of getting fresh air, are filled with exhaust gases expelled from the top cylinders during the suction stroke. The gases are compressed in the bottom cylinder, and exhausted again in the ordinary way into the exhaust manifold. After a few minutes, the temperature in the cylinder is raised sufficiently to put the fuel on to the bottom side also. The maneuvering of these valves is entirely automatic, as they are worked from the maneuvering shaft which is moved to the required position by means of an air servo-motor. There are six positions of this shaft marked on a dial placed at the control platform:—First, stop; second, six cylinders starting air; third, six top cylinders fuel, three bottom cylinders starting air; fourth, six top cylinders fuel; fifth, six top cylinders fuel, preheating bottom; and sixth, six cylinders fuel top and bottom.

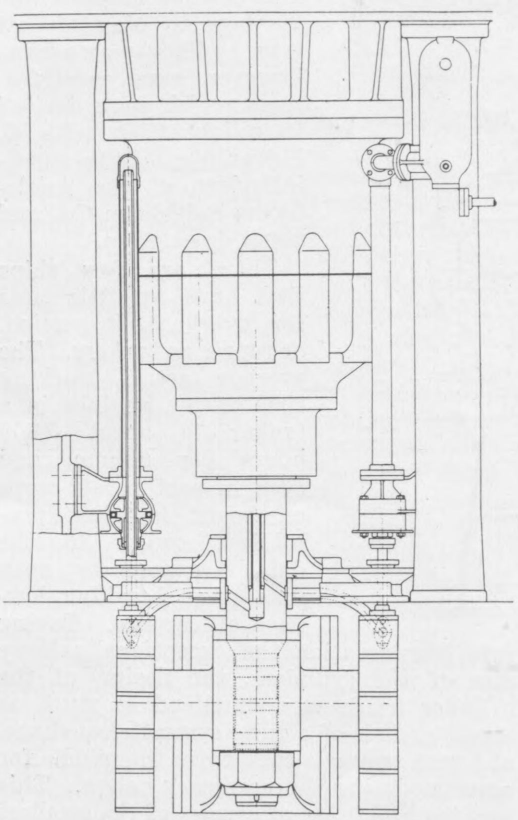


Fig. 7. Waterpipes for piston cooling

When the maneuvering shaft is in the positions one to five, the bottom fuel-lever is lifted off the cam, and the suction valves of the bottom fuel pumps are lifted off their seats, thus putting these pumps out of action. The type of fuel pump used on the single-acting engines is not suitable for the double-acting engine. It is necessary to use a separate pump for each cylinder. The fuel pumps, six in number, are double-acting, and are driven by eccentrics on the half-speed shaft. An Aspinall governor is provided to lift the suction valves when the engine speed exceeds a certain limit.

As the piston-cooling water (fresh water) must pass through the piston rod, a closed system of piston cooling had to be introduced instead of the open system used on the single-acting engine. The water connections inside the crank-casing, which are, of course, inevitable, are reduced to the smallest possible number, and the stuffing-boxes are fitted in accessible positions on the crank-case top, care being taken that no leakage-water can enter into the crank-casing. The stuffing-boxes are of the floating type, and do not exert any forces on the telescopic pipes which might cause fracture of the pipes, fig. 7. The hot water is led to a funnel, and hence to a compartment in the double-bottom of the ship. A piston-cooling water pump forces it through a cooler and back to the pistons.

It was previously mentioned that means are provided for judging the behavior of the pistons while the engine is running. It is indeed a disadvantage of the double-acting engine that, the cylinder being closed at the bottom end, it is impossible to watch the piston in the same way as in the single-acting engine. In the bottom-cylinder liner is a small opening closed by a spring-loaded valve, which is worked by a special cam on the camshaft and connected to a gage. The valve is opened at the end of the top combustion stroke, and remains open during the time that the gap between the two groups of piston rings passes the opening. Thus the gage is made to register the pressure in this gap. Leaking rings will cause the pressure in the gap to rise, which will show on the gage. This simple device enables the engineer to look, as it were, in the cylinder while the engine is running. It has proved to be very reliable and of great value, as even a tendency to leak can be detected. Prevention being better than cure, measures can then be taken to prevent the trouble becoming more serious.

In point of size the new motorliner for the Nederland Stoomvaart Mij. of Amsterdam will rank about the same as the P. C. HOOFT which is now building for the same owners. The new vessel will be called the CHRISTIAAN HUYGENS and will have a displacement of 21,700 tons on a length of 570 ft., breadth of 68 ft. 6 in. and a depth of 39 ft. 9 in. The two main engines will together provide about 11,600 s.hp. as announced in our last issue. There will be three auxiliary engines each of 650 b.hp. at 180 r.p.m. and a smaller auxiliary engine of 200 b.hp. at 300 r.p.m. The P. C. HOOFT was ordered in France, but the CHRISTIAAN HUYGENS will probably be built in Holland.

Sketches and Working of Oil Engines*

Major Bearings and Their Structure Considered From the Viewpoint of Maintenance and Adjustment

THE same conditions which were shown in preceding chapters to give oil engine framework its distinctive character also affect the constitution of the major bearings, comprising the wristpins, crankpins and main bearings. In the days when the oil engine began to make its debut, the conclusion that the high pressures would play mischief with all the bearings was arrived at by a very natural misinterpretation of the groping developments then in progress. In so far as this opinion referred to steam engines with oil engine cylinders grafted on them there was ample justification for it, but a moderate amount of study on the subject of modern oil engine framework was sufficient to show how the large forces resulting from the high pressures could be readily managed with the help of ordinary engineering common sense.

So great is the success of the close-hauled, direct-loaded oil engine framework that it does a great deal more than merely meet the increased demands. Wearing, heating and melting-out of bearings, regarded as a commonplace of steam engine operation, can be reduced to the point where they need no longer be regarded as a part of operating routine. Now we find uniflow steam engine designers religiously copying oil engine frames.

Connecting rod bearings, perched as they are on the end of an actively moving column, differ from the stationary ones because they combine a bodily movement with rotary motion about the crankpin and wristpin respectively. The fact that they are mounted on an actively moving member has certain definite implications as to the manner in which they are secured and as to their lubrication.

In one respect, at least, the bodily motion of the connecting rod bearings is regarded as beneficial, because the motion of the air around them tends to abstract more heat and thus keep them cooler than a bearing embedded in a mass of metal, say, like a main bearing located in an engine bedplate. Some engineers use this fact to account for the great intensity of pressure successfully withstood by wristpin and crankpin bearings. "Small-end" bearings may be loaded as high as 1500 lb. per sq. in. of projected area because of this fact and because the total swing or motion of the bearing is confined to a relatively small number of degrees on each side of the centerline. The "big-end" or crankpin bearing accommodates the same number of turns per minute as a bedplate bearing, and its ability to do so under a far greater pressure—800 to 1200 lb. per sq. in.—is attributed by many to the effect of air cooling.

Fundamental among the considerations affecting the design and maintenance of connecting rod bearings is the requirement for rigidity in the fastenings, exemplified by Fig. 114. Almost anyone's mechanical sense would indicate that a member subjected to the shaking forces to which a connecting rod is exposed must have all its component parts well secured. Yet the essential shape of any rod does not offer nearly the same opportunity for holding and supporting a bearing that is offered by the spreading outlines of a bedplate. Like all bearings, the ones fitted to the end of a connecting rod must be fully protected against deflections of every sort if they are really to support the oil film on which successful lubrication depends.

At the same time the bolts used for joining the halves of any connecting rod bearing are much more directly exposed to the heavy loads which the rod itself is transmitting. They must therefore be made correspondingly large, and in the hands of careless operators they offer the possibility of straining and distorting the bearings in the mere act of tightening up the nuts. Breakages of connecting rod bolts are among the more serious risks attending the operation of oil engines. They are not common enough, however, to have appreciably affected the widespread application of oil engines both to marine propulsion and to stationary power plants.

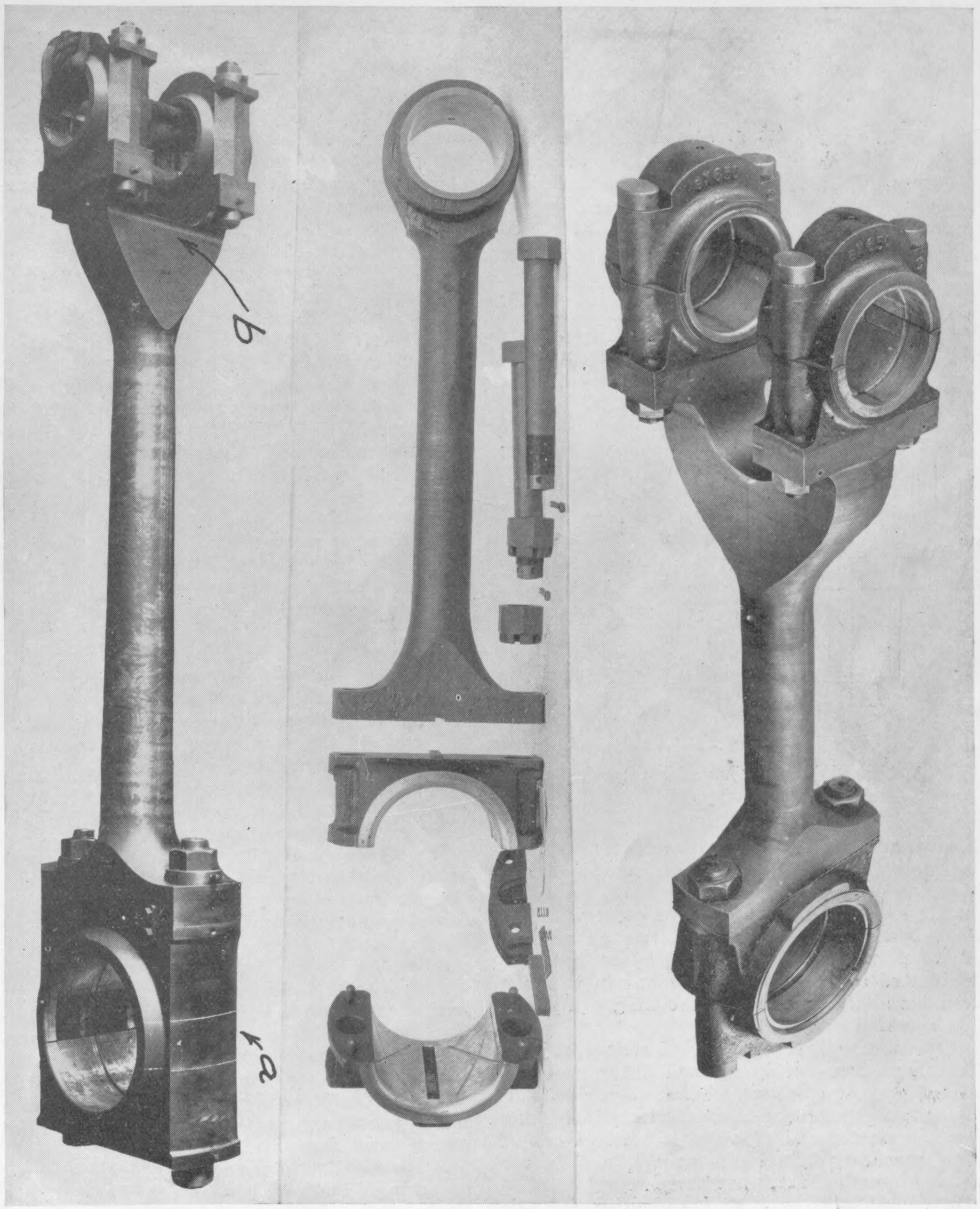


Fig. 114. Connecting rods and bearings typifying American practice

Wristpin bearings are generally made of cast bronze, while crankpin boxes are almost universally cast of steel. In both cases they are babbitt lined, although a certain number of engineers use plain bronze only for wristpin bearings. Bronze has great mechanical strength and readily conducts away the heat generated within the bearing. Steel is used for the crankpin bearing because its cost would be prohibitive on account of size if cast of bronze.

Some engineers seem to think that babbitt linings of generous thickness are an insurance against operating difficulties. As far as steam engine practice is concerned there may be some justification for that view. In the case of oil engines, however, the heavy pounding incident to the service tends to knead out and loosen a thick babbitt shell, a consideration which has favored the use of the thinnest possible babbitt linings. This alloy has little mechanical strength, and the smaller the quantity of it used for transmitting thrust and shocks, the less likelihood there is of its suffering damage. It is not uncommon, therefore,

*Summary of the Course of Instruction at the Polytechnic Institute of Brooklyn, N. Y., by Julius Kuttner, B.Sc., Licensed Chief Engineer, Editor of OIL ENGINE POWER and Associate Editor of MOTORSHIP. This is the twelfth chapter, the first one having appeared in the January, 1925, issue.

to find babbitt thickness as low as 3/16 in. on bearings having a diameter as large as 8 in.

Dovetail grooves are provided both in the bronze and the cast steel bearing halves for the purpose of securely anchoring the babbitt. As the metal poured into them cools and shrinks, its hold on the dovetails would tend to loosen, an effect which is counteracted in some cases by firmly peening the babbitt into place before boring it out.

Babbitting practice which is more generally approved for oil engine work consists in thoroughly tinning the shell beforehand, as can be done with the help of a large kerosene torch and a good supply of muriatic acid and solder. This precaution insures good bonding between the babbitt and the metal of the shell, and renders it less dependent on the holding power of the dovetails.

It is perhaps an open question whether modern conditions of oil engine operation at sea would permit of a crew doing their own babbitting in case a crankpin bearing were to melt out. Such contingencies have largely been ruled out by the intensive use of force feed lubrication which constantly keeps all bearings flooded. With the drip lubrication of steam engines and flimsy frames used for such machines in the past the loss of a bearing now and then was more or less to be expected. At

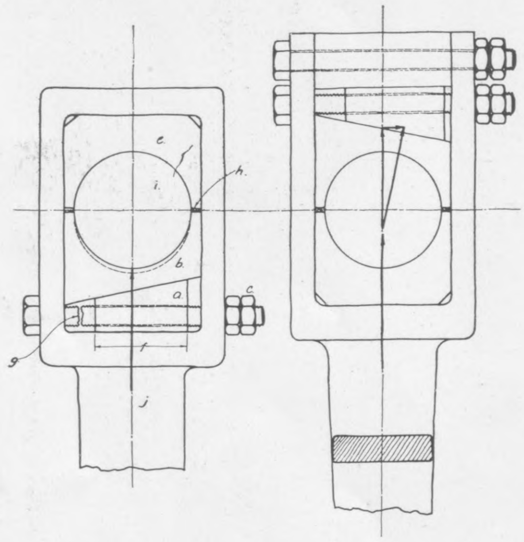


Fig. 115. Wedge-adjusted connecting rod bearings

the same time the generally easier conditions of the service and the considerably lower bearing pressures made it possible for a homemade babbitting job to answer quite well. It has been found entirely feasible on modern motorships to carry enough spare bearings babbitted and all ready to scrape in to make the installation of large babbitting equipment on shipboard superfluous.

The mechanical assembly of connecting rod bearings does not in general differ radically from that of stationary bearings except that bushings are sometimes used. Ease in forging an eye on the end of a rod is perhaps one of the reasons for using bushings, and in the case of smaller machines there would seem to be a certain amount of justification for this practice. Thin-walled bronze sleeves are driven into the bored eye of the connecting rod forging (Fig. 114) and the babbitt is frequently omitted for two reasons. The grooves necessary for anchoring it would tend to weaken the shell and prevent its being driven home with the requisite degree of tightness. As there is no ready means of taking up wear, slack in the relatively soft babbitt would readily tend to become objectionable, if indeed it would not cause it to be pounded out rapidly. Once a solid cylindrical bushing has become loose on the wristpin it must be driven out for renewal or rebabbitting. The solid bronze wears more slowly than the babbitt lined sleeve and is preferred because it avoids the relatively large amount of labor and expense involved in keying up. Bronze, on the other hand, is apt to score and groove even a hardened wristpin and involves a somewhat greater liability for serious damage than does the softer babbitt.

Distortion of a solid bronze bushing as the result of heating is apt to cause difficulty and makes it advisable to provide generous relief at the sides. As the pressure of the wristpin lies chiefly in a direction along the axis of the connecting rod, metal can be removed from the sides of the bushing. Side pockets for holding lubricating oil are thus produced, while the tendency for the bronze to "nip" the pin at the sides is obviated. Some designers saw the shell through on one side in order to provide leeway for expansion and thereby lessen its tendency to cramp and seize the pin. Whether or not the saw-cut is provided, good provision for locking the bushing sidewise and against rotation is essential in spite of its hard drive fit. Either a key or a dog-pointed set screw is provided for this purpose. In driving the shell home it is possible to rotate it slightly at each endwise blow so that the dog-point of the set screw will register properly when the sleeve arrives at its final position. Shells having the proper clearance around the pin before being driven in are often found to be tight afterwards; final reaming or scraping should therefore of course be done after the shell is permanently in place.

One of the oldest ways of providing adjustment and take-up in a connecting rod bearing consists in using the strap-and-wedge arrangement sketched in Fig. 115. Although well suited for steam engines and for low-pressure oil engines, its application to the high-compression machines is limited. It is being retained, however, by some prominent oil engine builders and there can be little question that they are having success with it.

As found on locomotives, the strap-and-wedge connecting rod has blunt rectangular ends against which the two halves of a split block-like bearing are hauled by means of a bent steel strap. The latter overlaps the rectangular rod-end and is spiked on by means of a long wedge and gib. Driving home the wedge tends to pull the strap further over the rod, hauling the bearing halves against each other and against the square rod end. Needless to say, such an arrangement lacks that rigidity and mechanical soundness which have come to be regarded as indispensable requirements of successful oil engine practice. From the point where the forged body of the rod terminates up to the extreme end of the U-shaped strap there are too many separate pieces placed end-to-end and somewhat indefinitely held together by flat stock of inadequate section. A locomotive box of this kind forms a strong contrast with the solid-forged connecting-rod eye bushed with bronze as described above. Whatever the drawbacks of the solid-bushed bearing may be from the point of view of adjustment convenience, there seems to be little chance of its suddenly disintegrating into many component parts when subjected to oil engine conditions.

A modification of the wedge bearing, as used on some oil engines, is shown in Fig. 115. In the right-hand illustration the strap is produced by means of two long prongs forged on the end of the rod and closed off by means of a rectangular metal block clamped in by means of a long bolt. Resting against the end-block is the adjusting wedge, the slanting face of which registers with a corresponding face on the outer bearing-half. As the wedge is pulled in the direction of its thin end by means of the threaded bolt, it exerts a sidewise pressure urging the bearing-block halves against each other and into the crotch of the fork. As long as the rod is thrusting, force is transmitted directly from the forging to the straight-sided bearing block, but as soon as the thrust changes into a pull—as it does periodically in a 4-cycle engine—tension is produced in the strap and makes itself felt throughout the entire assembly.

Pull in the rod causes shear in the bolt used for securing the end block. If the bolt is body-fitted, well and good; if not, it bears in the holes through the prongs and through the end-block at only a few points. Shaking loose is then of course inevitable, but is not always protected against, because of the ease with which the slack can be made good again by simply shifting the wedge-block. In most cases the amount of room allowed on the bearing faces for shimming or fitting is small and makes it easy to bring them out of shape by only a little straining at the wedge. Consequently such bearings are not usually set up very hard in the first place, a practice which additionally favors rapid loosening.

Tension in a 4-cycle engine connecting rod belongs to the class of repeated, and in many cases suddenly applied, loads which may be more destructive than steady loads several times as great. Tension is produced in the rod of a single-acting 4-cycle engine during the latter half of the exhaust stroke and the first half of the suction stroke. After the piston has passed something like its mid-position during its upward travel while exhausting, the speed of the wristpin center begins to reduce

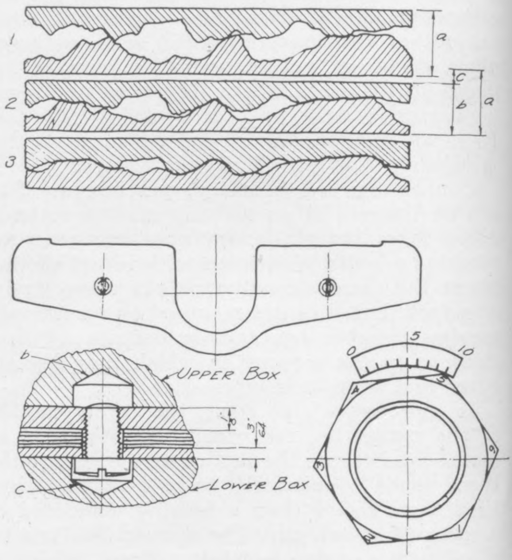


Fig. 116. Contact surfaces and shims

in response to the increasingly horizontal travel of the crankpin center. If at that moment the piston could suddenly be disconnected it would continue to travel upward at a speed exceeding 1,000 ft. per min., and if there is much slack in the bearing it actually does so until the top side of the wristpin has caught up with the upper bearing half in the connecting-rod. At the moment when that happens the piston's own weight has not yet appreciably slowed it down, whereas the connecting-rod end has been retarded to a much lower speed.

The rod must then apply a sharp jerk to the wristpin in order quickly to change its speed back to the proper value. In fact the rod must keep on exerting a pull of increasing magnitude in order that all the upward speed of the piston shall have been "killed" when the dead center is reached and reversal begun. Here again the piston would fall far too slowly of its own weight to enable it to follow the connecting-rod bearing center fast enough. Therefore, the rod must keep on pulling in order to increase the downward speed of the piston to a maximum exceeding 1000 ft. per min. at about the middle of the downstroke. If there is slack in the bearing the same thing happens as occurred on the upward travel. The wristpin leaves contact with the upper bearing half and a moment later strikes the lower half a metallic blow of considerable sharpness. This naturally reacts through all

the bearing fastenings and searches out every little defect in fitting which may produce looseness. The greater such slack may be at any time the more rapidly it is bound to get worse, because the further the wristpin can travel within the bearing slack the greater the difference in speed between it and the piston is bound to become.

During the entire time between the beginning of the compression stroke and the end of the expansion stroke the connecting rod is subjected to compression only while the load is confined to those halves of the wristpin and crankpin bearings situated closest to the body of the rod. Although the conditions prevailing throughout the compression and expansion periods are therefore generally favorable to the bearing fastenings, certain kinds of combustion may produce "knocks" which are probably not so beneficial. Without digressing at this point into the involved questions of fuel ignition, it may suffice to recall that although compression is supposed to cause continuous ignition of the fuel as fast as it is introduced into the combustion space of an engine, poor distribution and inadequate mixing may delay combustion of the incoming oil until a comparatively large amount of it is present. This may "go off" in all parts of the combustion space at once and produce that exceedingly sudden pressure rise known as detonation. The phenomenon is peculiar to oil engines and

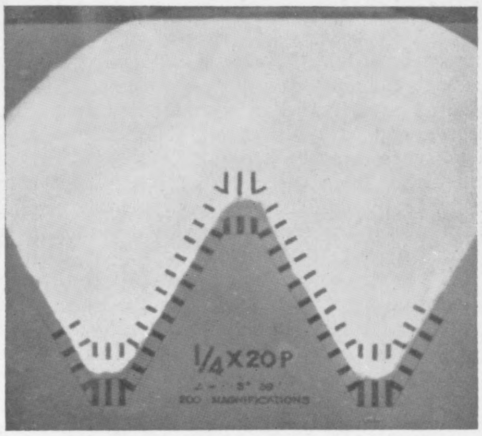


Fig. 117. *Thread outline imperfections*

is rarely if ever found in gas engines of low compression (below the ignition point) because the explosion flame must propagate itself from point to point just as fire spreads through a burning house.

Detonation and allied effects are often accompanied by a knock in the engine having a metallic or bell-like quality about it which suggests vibration of the tuning-fork variety. It almost seems as though the sharp suddenness of the compression force applied to the connecting rod travels as a wave from one end to the other and produces the sound which to many operators is characteristic.

Whatever the exact nature and causes of this metallic "ping" may be, no operator listening to it is likely to be pleased by the thought of what it is doing to his bearing fastenings. No designer whose teeth have been brought near to falling out by it is likely to keep on using any kind of a bearing arrangement in which there is a single superfluous part.

Such conditions as these, which are bound to be met with sooner or later in the operation of almost any engine, quickly tell on a design like that of the wedge type. As already pointed out, the provisions for making a solid job of it at assembly do not seem to be altogether adequate, and as soon as looseness develops it quickly increases itself with cumulating rapidity. If the bedding of any of the many surfaces butted against each other is imperfect, as diagrammatically indicated at *a*, Fig. 116, shocks of whatever kind will crush down the contact points and add to the looseness. If *a* is a fixed dimension connecting two of the surfaces as originally fitted and *c* is the amount by which they crush together as the result of loading and impact, then *c* also represents the additional slack produced in the bearing as already noted. The slack rapidly intensifies the action of shocks and further adds to the play in the bearing until its complete disintegration may result.

In a design like that illustrated in Fig. 115, such effects are apt to be particularly pronounced and may under certain circumstances even lead to the breakage of the wedge retaining bolt. It might be thought without extensive study that the wedge takes up the thrust or pull, as the case may be, very directly and that its retaining bolt is correspondingly free from anything like direct stress. It is to be noted, however, that there is a distinct and definite component tending to move the wedge along the axis of the bolt, and although this is a fraction rarely amounting to more than one-tenth of the direct load on the connecting rod, its frequent repetition and its transmission through a threaded bolt seriously weakened by the notching effect of the threads often leads to difficulties. Breakages of wedge bolts are a common occurrence.

Threaded fastenings subject to shock are looked upon askance by some designers because of the well-known difficulties attending the production of a really perfect thread. Commercial methods of optically testing threads, as done for example by the Hartness screw thread comparator, have revealed how minute variations in pitch and thread-angle may greatly reduce the metallic contact between thread and nut. The Hartness comparator built by the Jones & Lamson Machine Co. projects a greatly magnified shadow of the thread outline against a screen, bearing reference marks by means of which the extent of the inaccuracies may be gauged.

The ordinary method of judging how a nut fits on a bolt by hand-feeling it often leads to ridiculous results. The thread illustrated in Fig. 117 is seen to conform well to the standard and would ordinarily feel right. The specimen actually feels tight, however, because of the excess metal in the points of the V's. Fig. 118 is an ideal illustration of a thread and nut with correct thread angles, but with slightly differing pitches. Although the bolt threads bear well near the point where they enter the nut at the bottom, they stand clearer and clearer of the nut threads the further up they go. Near the top end of the bolt thread the clearance is entirely taken up the other way so that the bolt thread would begin to push the nut instead of pulling it. Such a thread-fit would also give an erroneous indication by feeling too tight, in spite of the fact that the bolt diameter is undersize. Assembled on an engine, it would be liable to rapid loosening because the small extent of the metal on which the load is concentrated (near the top and bottom) is incapable of standing the load.

Positive Designs

Considerations similar to these have caused the widespread adoption of connecting-rod bearings so designed as to insure the maximum degree of positiveness. An additional factor bearing on the choice of connecting rod fastenings for oil engines is that they should readily permit the rod to be kept at standard length notwithstanding bearing wear. As the compression volume of an oil engine is only about one-fourteenth of the stroke and as variations in the amount of cylinder length devoted to compression produce large changes in the maximum value of the pressure, the reasons for holding the length of the rod accurate within fairly narrow limits are at once apparent. Whereas the length of the rod does not bear a large proportion to the total stroke, variations in it sensitively affect the clearance length in the cylinder and under some circumstances may pull down the compression below the figure which insures positive firing and efficient operation. One of the regular duties of the operating engineer is to check the compression of his engine with an indicator while its fuel supply is cut off. If he has definite information that the clearance is correct, he will be able to trace low compression to causes such as bad piston rings, valve leakage, and the like.

Suppose, for example, that we are dealing with an engine having a stroke of 28 in. and a cylinder clearance length of approximately 2 in. If the wear-down in the wristpin, crankpin, and main bearing boxes is 0.04 in. respectively, as might be the case twelve months after an overhaul, the total drop of the piston crown would be 0.12 in. Although small in relation to the total stroke of 28 in., the wear of 0.12 in. amounts to 6 per cent of the total clearance length. Just what the effect of this

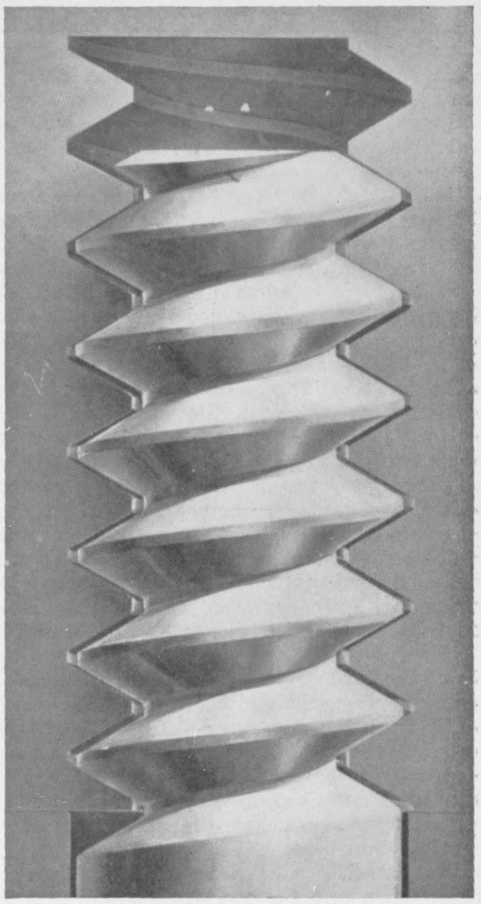


Fig. 118. *Thread lead inaccuracy*

on the compression will be is given with sufficient precision by the following formula:

$$\text{Loss of Com.} = \frac{8000 \times \text{Piston Drop}}{\text{Length of Stroke}} \text{ or } C = \frac{8000\,D}{L}$$

The units are inches and lb. per sq. in. In the case of our example we would have:

$$\text{Loss of Compression} = \frac{8000 \times 0.120}{28} = 34 \text{ lb. per sq. in.}$$

A normal compression of say 450 lb. per sq. in. would thus be reduced to 416 lb. per sq. in., a value such as to make the starting of an air injection engine questionable.

In addition to the usual provisions for taking up slack, oil engine bearings should therefore also have ready means for keeping center distances standard. The wedge type of adjustment illustrated at the left in Fig. 115, has the very substantial advantage that the wear of the bearing is also taken up in such a way as automatically to correct for the change in rod length. Note that the bearing half *e*, being subject to the small tension load of the rod, has practically no wear at all. As the slack in the half *b* is taken up, the pin *l* is automatically made to register again with the unworn bearing *e*, and the length of the rod

is corrected. In the alternative arrangement shown at the right-hand side of the figure, this is not the case, and, as the bearing half closest to the rod progressively wears, the effective length of the rod between centers becomes shorter and may produce a serious loss of compression as shown by the above calculation.

The wedge-adjusted bearing has been largely replaced by designs with more direct and positive fastenings, in which the requirement for maintaining the connecting rod length has also been taken care of. A good example which illustrates this tendency and at the same time may serve as an example of the broader considerations applying to such bearings is sketched in Fig. 120. Like most bearings it consists of the two halves *b* and *c*, let into a forged hole slotted in the enlarged end of the connecting rod. Note that the amount of metal left standing around the hole in the rod is considerable, as indicated by the cross section *q*. Such an amount of steel integrally forged with the body of the rod and completely enclosing the bearing is regarded as adding considerably to its security. Broad surfaces *k* are available between the back of the bearing and the forged metal of the rod and facilitate making up a sound joint at the point where the maximum compression load must be transmitted from the bearing to the rod. It is considered good practice accurately to scrape these joint surfaces by means of Prussian blue and thereby to insure against the battering-down action referred to in Fig. 116. Accurate fitting is, however, extended through the sides *m*, and lips or flanges of this bearing, which are scraped practically to as good a bearing as the surfaces *k*. The underlying idea is that any looseness which may develop, even if it is not exactly in the direction of the maximum thrust, will sooner or later lead to rattling on the part of the entire bearing. Only nominal loads are of course to be considered in scraping any surfaces such as *m*, but under certain conditions the side-slap of a rod, repeated millions of times in the course of an ordinary run, render it highly desirable to have the sides and flanges reliably fitted.

Note that, for reasons of assembling, the lips of the bearings are cut off at the sides to permit entering it into the forged eye, while the lip *y* on the upper bearing half is not repeated at the end *x*. In assembling this bearing the lower half *b* is first inserted sideways at a level sufficient to clear the lips and is then dropped down into place. Shims *n* are then laid into place and retained by means of shallow dowels *p*, after which the rod is turned upside down and the steel pad *u* laid into its recess. In the meantime the two lips on the bearing half already in place will generally fit snugly enough to retain the bearing for the time being. Finally the upper bearing-half *c* may be slid into place until it makes contact by means of the lip *v*. The rest of the assembling is now obvious. It merely remains to point out that the pressure screw *e* is of substantial diameter and bears in the rod over a long length *aa*. The nut *gg* serves to put the threads under an initial strain, a practice calculated to insure against the ill effects of the reversed shaking loads communicated to the screw. By squeezing possibly inaccurate threads together the initial strain generally produces enough actual metal contact to withstand subsequent loads. In double-acting engines this is done by locking two piston rod nuts against each other.

The lock nut itself is secured by means of a circular plate with a hexagon hole like the one illustrated by *g*. Small drilled holes for accommodating the lock screws *f* are spaced in such a manner that two of them will come near to registering with the holes *dd* tapped in the rod forging, no matter what position the nut may "bring up" in. The cap screws *f* are then finally secured by means of a wire threaded through drilled holes in their head and twisted

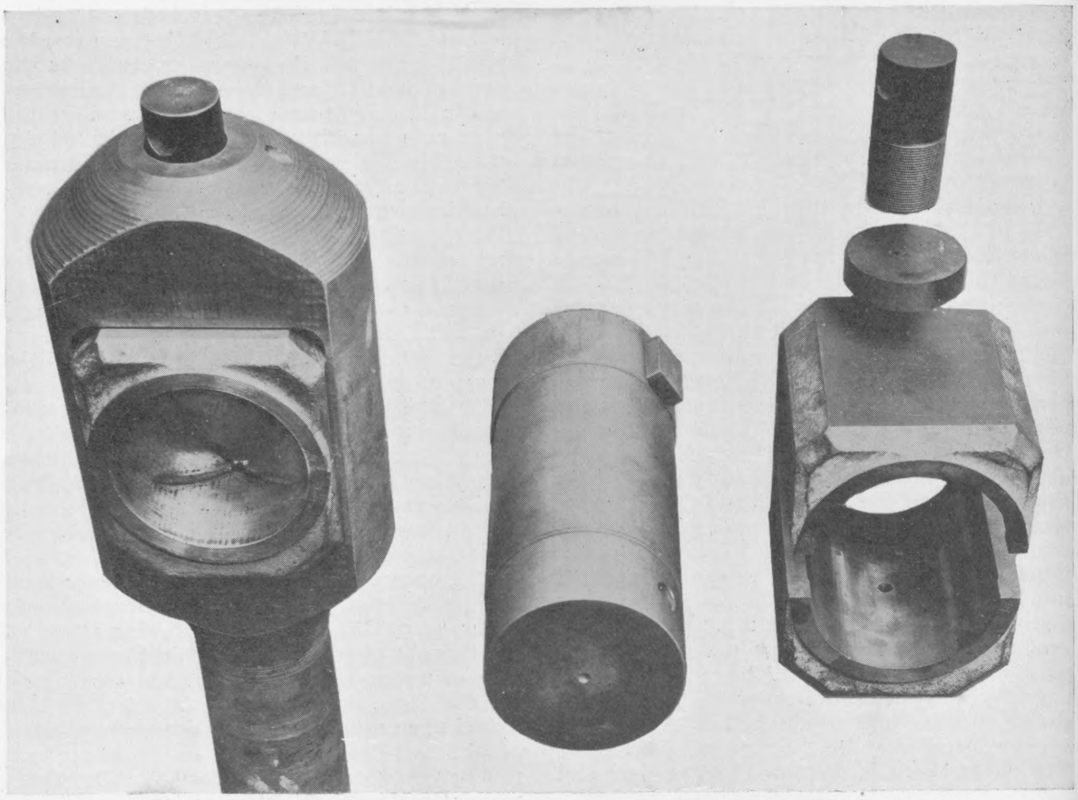


Fig. 119. Wristpin box parts of trunk piston engine; boxes and pressure screw

together as shown. There are some engineers who might be inclined to ridicule all these elaborate precautions against loosening illustrated by this design. Experience has shown, however, that the effort involved is cheap insurance against smash-ups. Even in those cases where the disintegration of a connecting rod bearing does not seriously maul up the engine and prepare it for the junk pile, interruptions in the engine's running may endanger a ship or inflict heavy money losses on an industrial concern relying upon it for power.

It is absolutely essential that the clearance on the wristpin be made independently of the pressure screw setting. The latter should always be set up with its proper tension after the clearance has been properly adjusted by selecting the shims to go between the bearing halves. Tightening of the screw should be done judiciously in order to avoid straining the bearing half, the circular steel pad being provided to distribute the load as much as possible and to prevent the screw from producing a local bulge. No hammer should be used in setting up on the pressure screw, which is purposely provided with a small square head to prevent the use of a large wrench. After a good steady strain has been applied by pulling on the end of the wrench, it is a good plan slightly to jar the wrench back with one or two blows from the palm of the hand. That is generally sufficient to prevent the bearing from cramping itself when it expands upon being warmed up.

Oil reaches the bearing through the drilled hole *r* and a registering hole in the lower bearing half. A relief *h* is eccentrically milled at the side of the bearings to act as an oil pocket to prevent nipping. The shims *n*, although narrow enough to register with the pocket and to avoid touching the pin over the greatest part of its length, have projections near the ends which practically touch the wristpin and help to prevent the escape of an undue amount of oil. For the same reason the relief pockets are milled only part way while the lands *j* on the babbitt are left standing in order to assist in retaining the oil. Shims are sometimes omitted altogether and clearance adjustments made by filing the joint faces of the bearing-

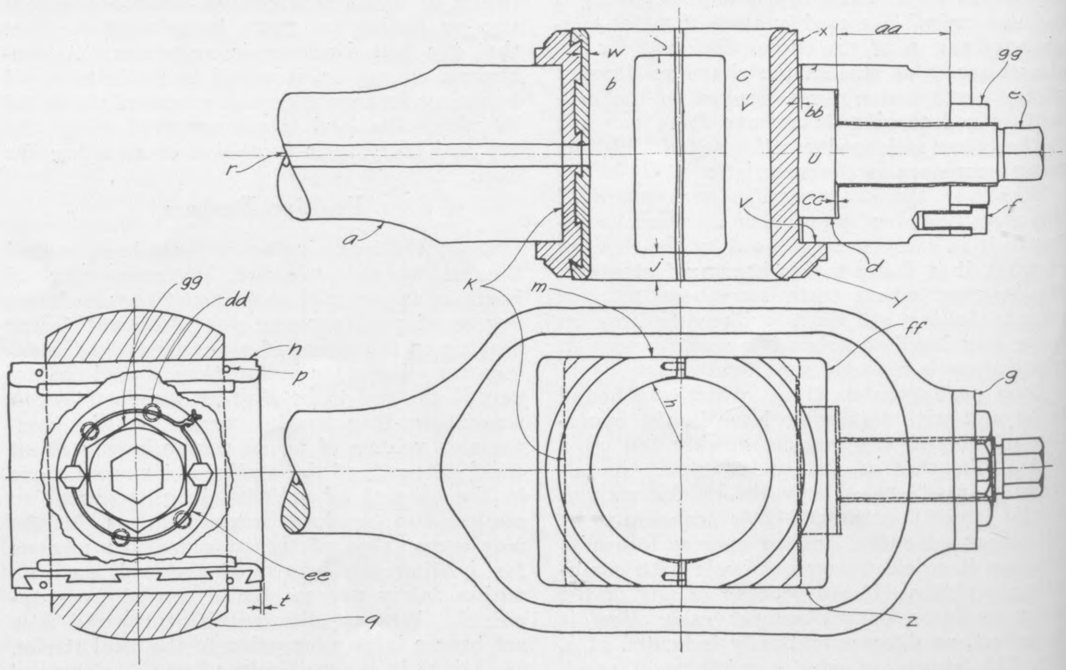


Fig. 120. Wristpin box assembly showing method of fitting and holding the brasses

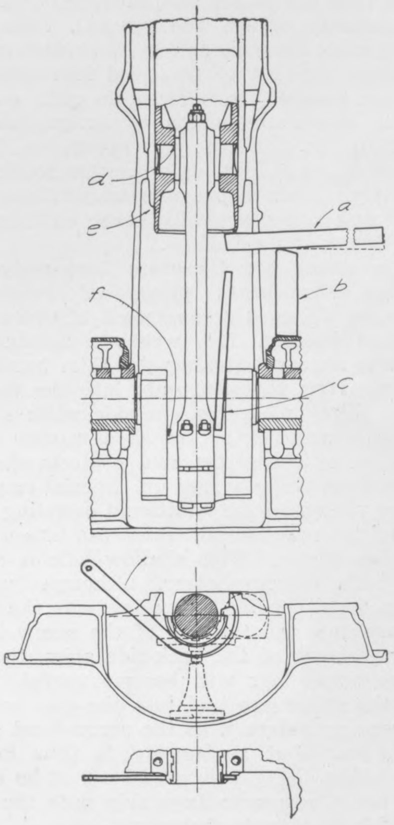


Fig. 121. "Jumping the piston"

halves. This, however, is a delicate operation requiring the services of a man who has had long experience in the use of a file. It is therefore better to provide leaf shims and to let the original machined faces of the bearing remain intact. Shims consisting of brass leaves, sweated together by means of solder, are coming into use because they combine all the advantage of the solid parallel piece with the added convenience of being suitable for peeling to effect clearance adjustments.

After the shells of a bearing like that shown in Fig. 120 have been babbitted, they are generally bored square with the faces *k*, an operation which may conveniently be carried out on the face plate of a lathe or by means of a boring attachment mounted in a large drill press. Owing to the extremely short length of the bearing compared to the length of the entire rod, it is quite essential that its alignment be watched as the scraping progresses. A method for checking the alignment of the wristpin bearing which has been found convenient for trunk piston engines is illustrated in Fig. 122, and consists in holding the straight edge *d* along the body of the piston while the distance *c* is measured. If, after the rod is shifted through the side clearance *a*, the measurement *c* is found to be the same when made against the straight edge in the position *e* the bearing surface *g* is bound to be true. It is obvious that even a very slight inaccuracy at *g* would produce a large difference in the measurement made at *c*. It is surprising to anyone who does it for the first time to note how little extra scraping on one end of the bearing will affect the measurements to a considerable degree.

Because of the relatively slight amount of rotation in this bearing, a small clearance is given to it, 0.003 in. generally being sufficient. A positive way to insure that this amount of clearance is obtained consists in putting in as many shims as will just make the bearing feel tight when the rod is oscillated by hand. After that, the bearing is loosened up again and a shim 0.003 in. thick taken out. Both at the final setting and while making the test just referred to, it is essential that the pressure screw be set up with the standard amount of tension. Any attempts to change clearance by varying the pressure exerted on the screw are absolutely wrong, at least from the point of view of what has been explained thus far.

A ready method of ascertaining whether clearances are somewhere near right is illustrated in Fig. 121, where the block *b* is used as a fulcrum for the wooden pry *a*. While an oiler bears his weight on the end of the pry in such a way as to force it sharply up and down, the engineer reaches up inside the piston and places his finger so that it rests partly on the piston boss and partly on the wristpin bearing box, as indicated by *d*. With a little experience it is then easily possible to tell whether the box is too snug or too loose. This procedure is known as "jumping the piston" and is applicable in cases where no knowledge concerning the clearance is available and where lack of time does not permit of an accurate determination.

Further jumping of the pry *a* will also reveal whether the crankpin box has the right amount of play, as may be felt at some such location as *f*. Failure to detect any motion at the point *e* is a sign that both boxes are too tight.

Side-play in the crankpin box may be roughly gauged by using a pry as shown at *c*. It is important that this be sufficient—usually about 0.03 in.—to allow for endwise shifting

Fig. 124. Crankpin box parts

of the crankshaft which occurs when the propeller thrust takes up the slack in the thrust block. At the same time it should be less than the side-play at *d* in order to prevent any rubbing at that point. The rod should always be entirely free of the piston so far as side-play is concerned, and its position fore and aft should be determined solely by the crank cheeks. As heating and other adverse conditions make the upper bearing more sensitive, everything possible should be done to relieve it from all but its direct rubbing load.

Sometimes the same two-bolt bearing found on crankpins is also used for the wristpin. Inside the piston, however, where space is limited, the accommodation of a sufficiently large wristpin, with circular-section bolts on each side of it, sometimes causes difficulty. Reference to Fig. 120 will at once show that to provide an amount of steel in the form of bolts equivalent to the cross-sections *b* would

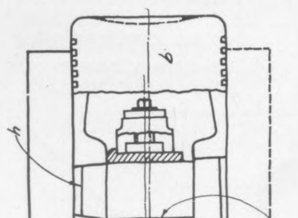


Fig. 122. Testing wristpin alignment

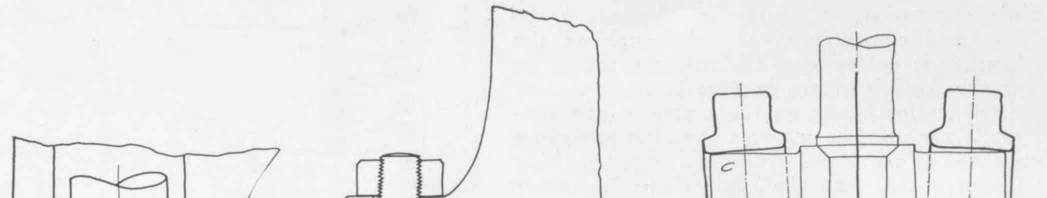


Fig. 123. Effect on alignment of fitted and loose bolts; deep-throated rod

necessitate the use of a bearing having a considerably smaller diameter.

On the crankpin the use of two large bolts, for fastening together the two bearing halves and for joining them to the enlarged forged end of the rod, is quite universal. In the first place obvious considerations such as assembling between the cheeks of the crank would compel the use of a bearing capable of being completely split in half and in the second place there is plenty of room on each side of the pin in which bolts of adequate size may be accommodated. Generally the upper bearing half is spigoted into the end of the connecting rod on surfaces machined in the lathe and therefore accurately in register with the rest of the bearing assembling. Rotation of the bearing center line in such a way as to destroy its parallelism with the top bearing is generally prevented by giving the two bolts a body fit capable of being made up with light blows of a babbitted hammer. What may happen if the bolts do not fit is shown exaggerated by Fig. 123. In some designs, as for instance, in Fig. 114, the keyway is cut by means of special machinery, both in the end of the connecting rod and on the upper surface of the top bearing half, for the purpose of insuring alignment. In that case, of course, it is unnecessary to have the bolts body fitted because the effect of the key supplants their doweling action.

In bolting a crankpin bearing to the end of the rod, flat sheet metal shims conforming to the outline of the rod foot are generally placed between it and the upper box. By properly selecting them the cylinder clearance may be adjusted in such a way as to give the right compression, and, as the bearings wear, the drop in the piston height may be compensated for in a similar manner. To do this it is not necessary completely to dismantle the box. It is sufficient to secure the halves temporarily together while the connecting rod nuts are removed and the bolts dropped down far enough to permit the sidewise removal or insertion of the necessary shims. Owing to the large surface of the sheet metal leaves, the possibility of their battering loose is considerably less than is the case with similar adjustment effected by the use of wedges.

Although outwardly this design of crankpin box does not differ markedly from that employed on marine steam engines for a great many years there are some differences in the method of keying it up. Steam engine boxes are generally built light enough to permit of their being pinched together more or less by straining at the bolts. For that purpose the corresponding nuts are marked with dials, according to which the amount of strain in the bolt and consequently the clearance on the bearing is determined. A nut with markings of this kind is shown in Fig. 116.

Oil engine boxes, on the contrary, are generally designed so massive that the squeezing method of adjusting clearances is not so easy to carry out. At the same time the higher intensities of bearing pressures found in oil engines render it questionable whether such practice would give good results. It is therefore quite usual to find that the nuts on the connecting rod bolts are invariably sledged up to standard tightness while the necessary clearance adjustments are produced by varying the thickness of the shims between the halves. It is a good plan to sledge the end of the wrench up to the point where the hammer begins to show a distinct elastic rebound. Once that point has been reached it is safe to assume that all the accidental looseness possibly resulting from waves and bends in the shims and similar causes has been taken up and that the job has been made up solid throughout. Straining up the bolts beyond the point where

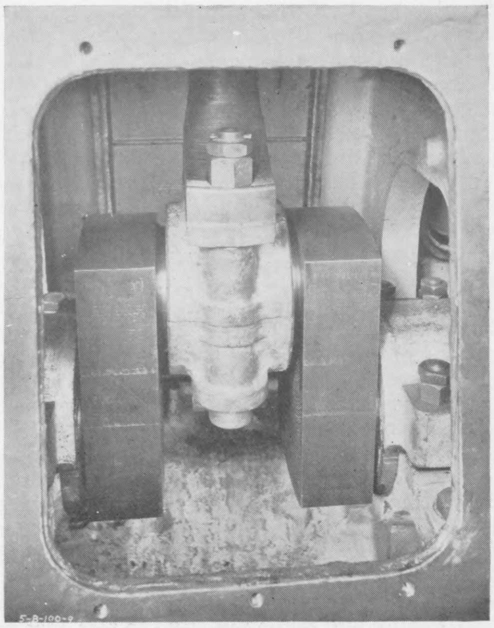


Fig. 125. A typical crankpin assembly

the hammer begins to rebound off the end of the wrench would seem to invite the danger of damage and to serve no useful purpose.

Like the wristpin bearings previously discussed, the crankpin boxes are provided with a generous side relief for the same reasons. Oil is retained by the pocket thus produced while the danger of nipping at the sides is obviated. As before, in order to prevent the escape of oil supplied under pressure, the milled relief is not carried clear across the bearing and the contour of the shims is formed with the same end in view.

For the sake of accurate adjustment a bundle of shims should contain a large number of thin leaves. These, however, are difficult to handle, cannot be readily fastened together and are liable to wrinkling and other damage while being removed or replaced. Shims must register neatly with the bearing faces between which they are placed and, although they must not actually scrape the journal, their ends should come close enough to its surface so that an undue amount of force-fed lubricating oil may not escape. It is therefore quite customary to dowel the shims to accomplish this object and to avoid the patience-trying, finger-squeezing manipulations otherwise required at assembly. Thin shims are unsatisfactory to dowel and are practically never entirely free from kinks if used alone.

Thin shims are therefore frequently held between sheet-brass plates of substantial thickness. A good arrangement of this kind is sketched in Fig. 116, where a fillister-head screw is shown fastening the shim bundle together. It is threaded only into the thickest of the shims, placed on one side while a plate not quite as thick serves as a washer under the head of the screw, and protects the thin leaves from being burred up. Special emphasis is also placed on the additional doweling function of the screw-head, which fits into a drill-point as shown. This shallow hole is drilled into both bearing-halves, although initially required only in the lower one. As the shims are used up and the end of the screw begins to project out of the back-side shim, the hole in the upper box will become useful. Note that the shims are laid into the gap between the bearing halves with the screw-head downwards and that registering is thus insured even before the gap is closed up. The screw-head dowel compares favorably with the plain straight pin dowels frequently used.

In some engine practice the space between the two bearing-halves is quite frequently taken up by means of a large distance piece such as shown in Fig. 123*b'* and 114*a*. It extends over a depth corresponding roughly to that occupied by the side relief and, as it does not touch the rod, it is babbitted only at the extreme ends for the purpose of retaining oil. Just what the purpose of such a thick distance piece in addition to leaf shims should be has not been altogether explained. It simply adds to the number of parts to be manufactured and fitted and it increases the liability of the bearing structure to loosen. Modern designers

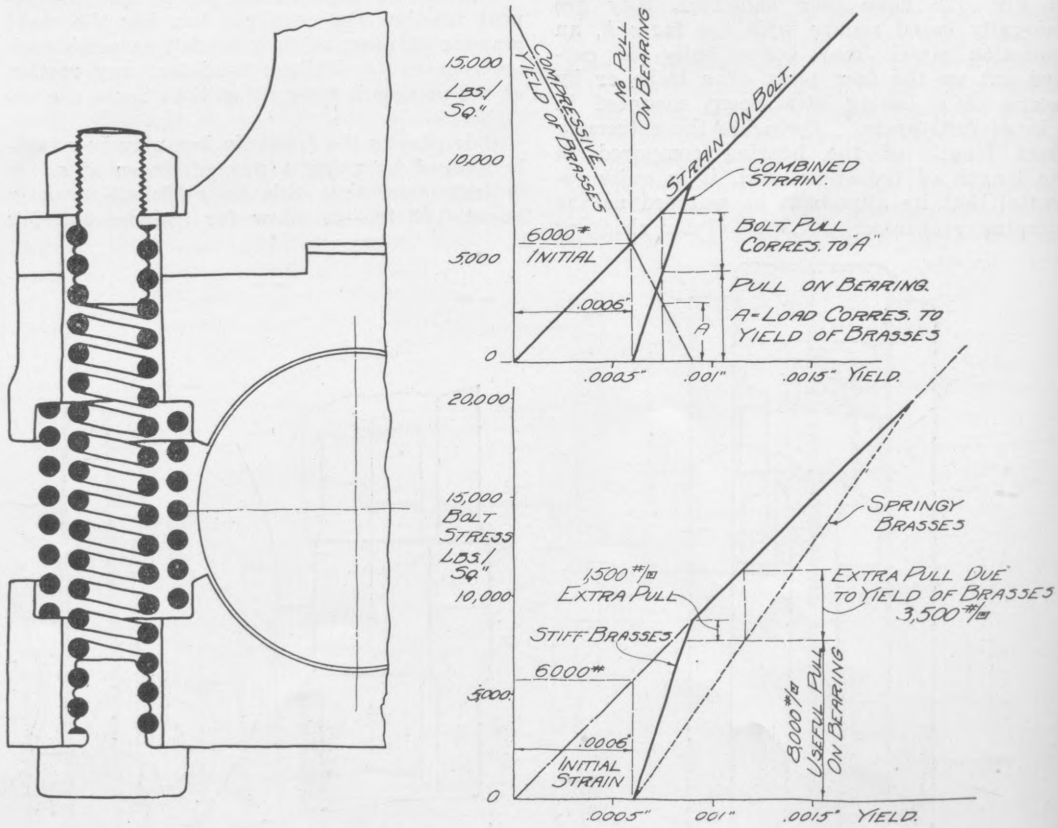


Fig. 126. Rigid boxes reduce bolt strain and insure against breakage

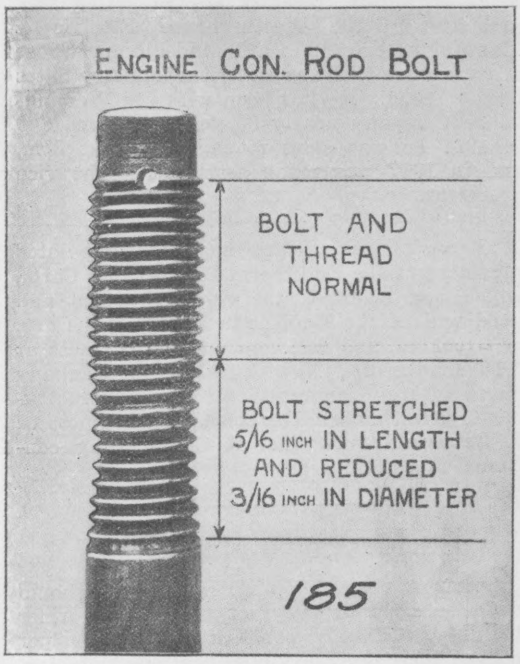


Fig. 127. Overstressed crankpin bolt

try wherever possible to eliminate extra pieces not absolutely required, and unless someone volunteers better reasons for the distance piece here referred to there is every prospect of its being left behind in the march of progress. The fact that it is practically never found in modern oil engines may be regarded as a sign of the times.

Whether an operator judge the tension with which he is setting up his bolts by means of marks or by the rebound of the sledge from the wrench, he may often be puzzled by the question: Does the setting-up strain add itself to the load imposed on the bolt later when it begins to take up the normal pull due to the engine's workings?

That question is exactly similar to the one raised by the tightening up of cylinder head studs (MOTORSHIP, August, 1925, p. 604), and which had to do with the possible addition of the gas pressure load to the tension initially produced in the studs. The conclusion there reached indicated that if the gasket is a hard one the gas pressure load produces no additional strain because the gas cushion momentarily replaces part of the frame reaction against which the stud strain is balanced at all times when there is no pressure in the cylinder. It makes no difference to the bolt whether it is exerting its tension against the frame or against the gas pressure.

Reasoning of a similar kind is applicable to connecting-rod bolts. If they are strained up against a highly rigid crankpin box structure the working pull on the bearing does not greatly increase their strain. The pressure on the shims is relieved to the extent of the working pull while the bolt-strain remains unchanged. If, on the other hand, the bearing box has inadequate stiffness and yields considerably to the initial sledging-up strain, then the re-expansion of the compressed box will impose an extra load on the bolt over and above the normal working pull transmitted by the connect-rod. As previously discussed, the pull in the connecting-rod of a 4-cycle engine is produced by the inertia of the reciprocating parts and may amount to 1/4 or 1/5 of the maximum gas pressure load.

In view of the fact that 100 per cent rigidity is a property not actually possessed by anything, not even by the most rigid crankpin box ever designed, the formal answer to our question needs to be supplemented.

Like any body exposed to the action of forces, a connecting-rod bolt carries load in proportion to the amount by which it yields. With every ton of load on a bolt there is definitely a certain percentage elongation and the bolt fails to take its load until it yields to the point where its own stretching force balances the load imposed on it. Exactly the same thing applies to the compression load borne by the crankpin box.

With these truths clearly in mind it will not be especially difficult to trace out the meaning of the diagram in Fig. 126. After the bolt has been sledged up and before the engine has begun to work, the tension load in the bolts exactly balances the compressive load in the box, while the reaction on the crankpin journal is zero. As soon as the live load begins to come on, the bolt stretches still more, but not in direct proportion to the live load alone. The bolt is balanced against the sum of the live load and the compressive load from the squeezing of the box.

Due to the bolt's extra elongation, the compressive reaction from the box is relieved so that the bolt's power to resist the live load is increased both by its own stretching and by the decrease in the useless load from the box. The more rigid the box the less extra stretching the bolt will have to do in order to transfer its force from the shims to the useful work of resisting the live load.

In the upper diagram the method of plotting the forces and the strains due to them has been indicated in a way which, in connection with the above, it is hoped will be self-explanatory. In the lower diagram the conditions of a springy box and a fairly rigid box are compared, 8000 lb. per bolt being assumed as the useful outside pull for each of the examples. Note that with the weak box the bolt must stretch until it picks up an additional load of 3500 lb. before it frees itself from the box reaction sufficiently to leave the necessary 8000 lb. left over. In the case of the rigid box the increase in bolt stress is only 1500 lb., making a total of 9500 lb. as against 11,500 lb. of the inferior arrangement.

This analysis throws an interesting sidelight on boxes which have clearance adjusted at least partially by markings on the nuts and it may help to explain some connecting-rod bolt breakage hitherto not fully accounted for. Just what punishment a bolt may get in service is illustrated by Fig. 127.

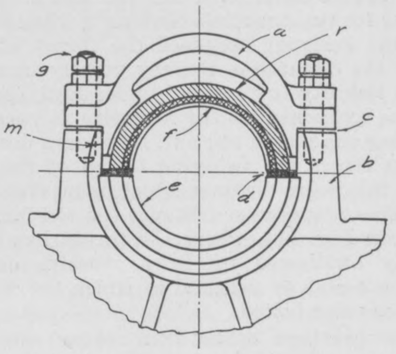


Fig. 128. Main bearing assembly

Some designers have apparently approached the matter from the other end: they have made the connecting-rod bolts extra long in order to increase the relative yield between them and the crankpin box. Long bolts are shown in Fig. 125 and are found also in modern boxes lacking the piece *a*. In these designs the bottom half is made practically square clear across the bottom and the bolt heads project beyond the lower contour of the assembly. Not elegant looking, perhaps, but wiser than most people may realize.

Forked connecting rods with two bearings at the top instead of one are very generally used for crosshead engines, although a few crosshead machines are found in which a connecting rod with a single top-end bearing replaces the forked arrangement. It is claimed that the single bearing is easier to keep aligned than the pair. On the other hand, its use makes necessary the forking of crosshead structure, increasing the height of the engine correspondingly and sacrificing a certain amount of accessibility. It is not quite so convenient to key up on a single bearing straddled by a massive crosshead structure.

One argument in favor of the single top-end bearing is illustrated by the sketch of Fig. 123. This is a true-to-scale copy of a steam engine connecting-rod placed in service on a large 2-cycle Diesel engine in a recent overhaul on which over 80,000 lb. of babbitt were used. Gracefully proportioned and well-suited to

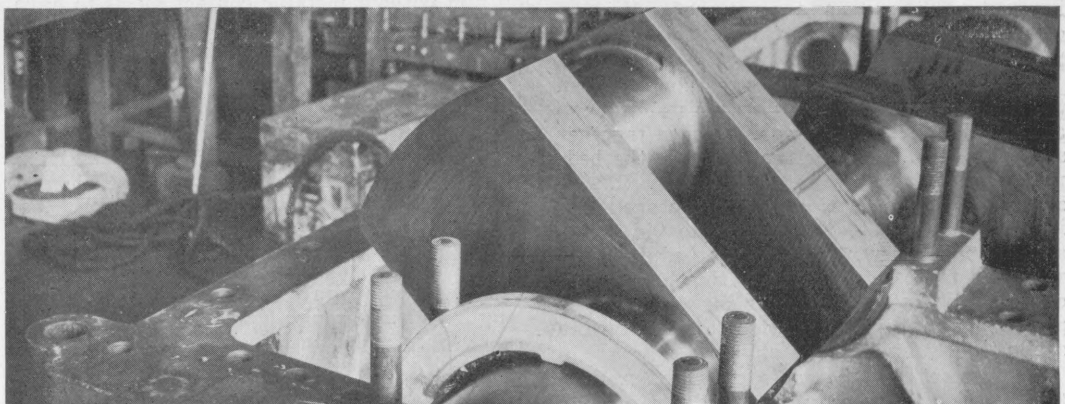


Fig. 129. Main bearing in bedplate showing removable bearing shell

steam engine conditions, this rod was a source of grief for reasons made obvious by the sketch. Why the designer deepened the throat of the rod by the distance *a*, thereby greatly increasing its liability to "spring" under load, cannot fully be explained by the necessity for accommodating the piston rod nut. In modern designs the nut clears the swinging throat of the rod by the minimum distance which is mechanically safe. Compare for instance the rod forging shown in Fig. 114, where the throat has been entirely swallowed up in a massive chunk forming a slab or pedestal to which the wrist-pin boxes are bolted.

Main bearings differ from those used on connecting-rods chiefly in the fact that the babbitt is cast into removable cylindrical shells held in recesses bored half in the bedplate and half in the bearing cap. As a matter of fact bedplates are bored after the initial planing and drilling operations have permitted the bearing caps without any shells in them to be seated; a single bar is generally used, and all the bearings in a given section of the bedplate are generally finish-bored at one setting. The planed surfaces of the bedplate are used for registering the bar, while the continuous travel afforded the boring tool by the presence of the bolted-on bearing caps further assists in the production of a highly accurate machining job. It is frequently found that the flat sides of the bearing caps are fitted deeply and snugly into the corresponding planed recesses in the plate and that they are positioned on the centerline independently of the cylindrical parts, such as the shells and crankshafts inserted later. In scraping the sides *m* of the bearing caps (Fig. 128) prior to assembly care should be taken that they are well and uniformly bedded on the sides. They should not drop into place of their own weight, but should require moderate tapping with a babbitt hammer before they do this.

Studs for holding down the bearing caps are placed as close to the planed bedplate recesses as can be done without danger of the stud or bolt holes breaking out. The shorter the span between opposite pairs of bearing bolts the less the bending strain on the cap and consequently the less its distortion is likely to be. Here again, as in the case of the crankpin boxes, the practice of springing the bearing out of shape as a means of adjusting clearance has no place so far as modern Diesel practice is concerned.

Cylindrical babbitted shells inserted between the upper and lower bored recesses of the cap and bedplate respectively are pinched together against shims. Neither the caps nor the bedplate actually come into contact with the shims. Pressure exerted on the top shell-half is communicated to the lower one via shims and from the lower shell to the bedplate. A small air-gap *c* between the bolting lugs of the cap and the bedplate surface insures that the pressure will really be exerted to make up the shells tightly against the shims.

Good practice appears to call for scraping the exterior surfaces *r* of the shells against their seatings in the caps and the bedplate. That is done to prevent localized metal contacts from being battered down as the engine works and to increase the elimination of heat from the bearing by conduction to the bedplate. Water cooling for main bearing shells is rarely used on Diesel engines for the reason that sound framing design keeps bearings in line and eliminates the heating regarded as unavoidable in steam practice, in spite of the lower specific bearing pressures characteristic of it.

Shells are secured against rotating with the shaft by means of short dowels registering the upper halves with the cap, while endwise movement is blocked by means of circumferential lips or shoulders. As soon as the cap is lifted and the upper shell-half with it, the lower one may be "rolled" out without disturbing the crankshaft. If this is found difficult the weight of the shaft may be eased off by means of a small jack placed under a crankweb adjacent to the bearing. Should the shell then still fail to budge, it can nearly always be started by getting a toe-hold on it after the manner suggested in Fig. 121.

Rectangular bearing notches are today rarely found in Diesel engine bedplates, because of the enormously greater convenience of the method just described. However, the advantage of being able to roll out the bearing shell may be retained even with the rectangular notch (Fig. 130) if a separate cylindrical shell be fitted into the lower bearing block as indicated. An additional advantage claimed for such an arrangement is that flat shims may be used under the block for re-aligning the bearing in the case of wear without rebabitting the lower shell-half. Arguments against the somewhat unusual arrangement shown in Fig. 130 are based on the fact that an extra piece is added and that the readjustment of the shims requires extreme care. One of the foremost builders of 4-cycle engines of our time claims that force feed lubrication coupled with spring-proof framing design have reduced main bearing wear to the point where keying-up no longer forms a part of normal operating routine. According to that the ideal condition in which the journal really rides on the oil film without metallic contact seems to have been realized.

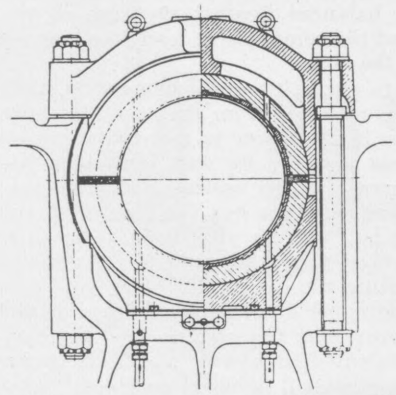


Fig. 130. Main bearing with through-bolts

The long through-bolts shown in Fig. 130 are sometimes used also on bearings without the rectangular-sided lower block and illustrate a point that is worthy of notice. Studs used for hauling down main bearing caps must be threaded into the iron of the bedplate, and cast-iron makes notoriously poor threads. As the holes for through-bolts do not need to be tapped, they can be placed closer to the bearing centerline than studs and help to reduce the bending strain in the cap. The great length of the through-bolts also decreases the extra loads added to the sledging-up strain by the engine's working, as explained in connection with crankpin bolts.

Personal Notes

J. Muysken, director and general manager of Werkspoor of Amsterdam celebrated on Jan. 1, 1926, the silver jubilee of his connection with that company. He joined Werkspoor on Aug. 15, 1891 and was appointed general manager Jan. 1, 1901. Under his management Werkspoor was the first engineering company, outside Russia, to take up the construction of reversing Diesel engines for ship propulsion. He completed in 1910 a 450 b.hp. engine for the historic VULCANUS, which is still in service in the Dutch East Indies. The power of the engines which Werkspoor has built under Mr. Muysken's management has grown from the little VULCANUS engine to the 4000 b.hp. double-acting engine of which 12 sets are being built for the Asiatic Petroleum Co. alone.

S. L. Nicholson, recently elected acting vice president of the Westinghouse Electric & Manufacturing Co. is a Philadelphian, whose acquaintance with the electrical industry dates back to 1887. He has been with the Westinghouse Company nearly 30 years. From 1909 to 1917 he was sales manager of that firm, and in 1917 was made assistant to the vice president.

J. Barraja-Frauenfelder has been appointed president of the Equitherm Engineering Corp., which has acquired the assets, patents and good will of the Equitherm Controlling Corp. of Brooklyn, and will continue the business at 8-10 Bridge St., New York. This company manufacturers temperature controlling instruments of all kinds. The consulting business of J. Barraja-Frauenfelder & Co. is being continued at the same address.

Messroom Maxims

Steam engineers joining motorships should not lose sight of the fact that their former training will only constitute about 50 per cent of their necessary qualifications as motorship engineers.

And that reminds us that where there is so much smoke at the exhaust pipe there must be mighty poor combustion in the cylinder.

One way to drop a wrench in the bilge and leave it there successfully is to accuse some departed member of the crew of having stolen it.

Doubling the diameter of a pipe increases its capacity four times. This might apply equally well to a man if we thought of food capacity only, but speaking of work—well, that's different.

The fact that small boilers and steam auxiliaries constitute a part of some motorship's equipment means that a thorough knowledge of these should be a part of motorship engineers' equipment.

The centrifugal purifier is more than a decoration for the engine room.

The quality of the souvenirs given away by enterprising salesmen does not always indicate the quality of the product they sell.

It is a good plan to wash the compressor out with soap and water just like it is a good plan for a man to take a bath.

Some men who ask questions are prompted by more than idle curiosity. At any rate in our oiling days we obtained much useful information from engineers willing to answer our questions.

Because we find the new job different from the old one we should not jump to the conclusion that it is not right.

By using the hand fire pump occasionally we may avoid answering some embarrassing questions propounded by the Steamboat Inspectors.

By the way: Why not have some Motorship Inspectors?

The fact that we know more about our own job than any one else, does not indicate that we cannot learn just a little more.

When a man wants a berth he is generally prepared to go to work when he finds one.

Perhaps no one knows the need of standardization of pipe, bolts, nuts, threads, etc. any more than does the engineer.

Despite the many advances we have witnessed in science and mechanics, rubber remains rubber and makes a poor oil joint.

That reminds us that sheet cork makes oil-tight joints at the crankcase doors.

The fact that designers sometimes have machinery placed in inaccessible holes does not mean that it will require less attention. Space forbids our saying all we think of such designers.

By placing one hand on a bus-bar a mulish kick may result if the other side is grounded. That is one way to get a *kick* out of our work.

Recent Technical Reports and Addresses

A Review of the Principal Monographs on Motorships. Marine Oil Engines and Associated Subjects.

Hints and Deductions from Experience in Operating Oil Engines

By J. C. Phillips, M. I. Mar. E. Published in the Oct. 1925 *Transactions of the Institute of Marine Engineers, London, Eng.*

In the form of a conversation between a second engineer and a junior Mr. Phillips has summarized the advice and instruction which five years' motorship experience in six different vessels has led him to believe will be helpful to young engineers. Though the practical help which the author offers is valuable in itself, the real lesson which he teaches is that operating success is dependent most largely upon constant observation of detail, methodical inspection and careful completion of all duties. His method of instruction is paternal instead of professional. He obviously seeks to train the character of the engineer instead of developing a book knowledge. For that reason the contribution of Mr. Phillips can be commended to all young engineers, even though they may never be shipmates with the same type of engines as the author has drawn his operating experience from.

Reminiscences of Early Diesel Engines Troubles and Mishaps

By R. McKinnon, M. I. Mar. E. Published in the Oct. 1925 *Transactions of the Institute of Marine Engineers, London, Eng.*

Confining himself to the narration of serious troubles within the experience of his friends and himself, the author is careful to ward off unintelligent interpretation of his theme by stating that his motive is to help those engaged in the "work of perfecting, and of manipulating, one of the greatest inventions of modern times."

Valve troubles due to dirty fuel, explosions due to leakages of fuel oil into the starting air system, excessive wear of crosshead bearings due to dirty lubricating oil, breakage of compressor valves and a crankshaft failure traced back to persistent excess pressures in the cylinders are the chief troubles narrated and explained. The means adopted to obviate recurrence form the principal interest.

Driving of Ships by Oil Engines with Hydraulic Mechanical Transmission Gear

By Dr. Bauer, Hamburg. Published in the Dec. 1925 *Transactions of the Institute of Marine Engineers, London, Eng.*

This is a translation of the paper read at the last meeting of the Schiffbautechnischer Verein in Berlin and dealing with the development of the hydraulic transmission system of the Vulkan Werke of Hamburg. Eight machinery installations have been ordered on this system, ranging from a 490 hp. tug to a 4100 hp. freighter of 9500 tons d.w.c. The 2000 tons d.w. cargo ship VULCAN built by the Vulkan Werke for demonstration has been operating since June 1924, and the wear on the transmission system is stated by Dr. Bauer to have been negligible. The system consists of two or more oil engines of the non-reversing type driving through pinions to a gear wheel on the propeller shaft, the pinions taking the drive from the engine shafts through hydraulic couplings for ahead and through hydraulic transformers for astern. The hydraulic parts of the system have been developed by Dr. Föttinger. As the main advantages of the system Dr. Bauer mentions the elasticity of the coupling, the possible reduction of tailshaft diameter consequent upon the more uniform turning moment, the use of a single screw with two engines—permitting very reduced ship speed and inspection of one engine without stopping the vessel—,elimination of air for reversing—with saving of weight and cost of air receivers and auxiliary compressors—,and reduced propeller speed through the use of gearing. When he leaves the realm of his subject proper, Dr. Bauer loses himself in fantasy, and he concludes with a proposal for star-type engines operating at 1000 r.p.m., with 230 cylinders for a 23,000 b.hp. installation.

Marine Oil Engine Trials Committee Report No. 3

Trials of the m.s. PACIFIC TRADER. *Published by the Institution of Mechanical Engineers, London, Eng.*

This forms the third report of the series, the first and second of which were reviewed on pp. 374-375 of the May 1925 MOTORSHIP. The PACIFIC TRADER is a slightly larger and more powerful vessel than either the SYCAMORE or DOLIUS already tested. She is owned by Furness Withy & Co., and has a Doxford opposed piston engine.

Characteristics of m. s. Pacific Trader

Length b.p.	420 ft. 0 in.
Breadth molded	58 ft. 0 in.
Draft, mean loaded	26 ft. 8 in.
Displacement, loaded	13,933 tons
Deadweight capacity	9,380 tons
Sea speed	11½ knots
Power	2,900 s.hp.
Revolutions	87 r.p.m.
Propeller diameter	17 ft. 0 in.
Propeller pitch	15 ft. 0 in.
Blade area	91 sq. ft.

For more ready comparison with the other vessels the following figures may be quoted. Endurance at 11½ knots is estimated to be 18,500 miles. Length of engine room is 56 ft. 3 in., plus the thrust recess. Weight of main engine, flywheel, shafting, stern gear and propeller is 433 tons. Total machinery weight 655 tons, plus 77 tons for the water in the jacket system and in the boilers. The weight of the main engine alone is equal to 278 lb. per s.hp., compared with 382 lb. in the SYCAMORE and 260 lb. for the DOLIUS. The average compression pressure at rated load is 280 lb. per sq. in. and the average m.i.p. 101 lb. per sq. in.

As in the two previous reports, the mass of data furnished by the tables is compendious, and if one accepts it with proper regard to the liability of errors inseparable from such test reports it is very valuable. The Committee has respected the criticism directed at the first two reports and has obviously endeavored in a whole-hearted manner to eliminate the weaknesses of certain test methods. A much more satisfactory indicator rig was employed, for instance, and the deduction of the heat carried away by the exhaust is acknowledged to be unsatisfactory in a 2-cycle engine on account of the escape of scavenge air with the burnt gas.

Most of the engine trials were made with a Mexican fuel of about 18,250 B.t.u. upper calorific value. At rated load the engine shows a consumption of about 0.415 lb. of this fuel per b.hp.-hr., which on a special test with fuel cams advanced 3 deg. was reduced to about 0.405 lb., coincident with an increase of max. cylinder pressure from 570 lb. per sq. in. to 670 lb. per sq. in. The mechanical efficiency at rated load and normal cam setting was 87.5 per cent.

Sea trials were made for speed with measurements of thrust, and trials were made also for fuel consumption at sea. The torsionmeter measurements were omitted, which is to be regretted, because they might have shed light on the contradictory torsionmeter results noted in the trials of the SYCAMORE and DOLIUS. The report is interesting to naval architects as well as engineers.

Measured Mile Trials and Other Ship Propulsion Data

By G. S. Baker. Published by the N. E. Coast Institution of Engineers and Shipbuilders, Newcastle, Eng.

In this paper Mr. Baker of the experimental tank staff at the National Physical Laboratory, England, compares results obtained in ship trials with the estimates made from model experiments. Of six vessels covered in detail by the author, four are motorships: WELLFIELD, DOLIUS, PACIFIC TRADER and SYCAMORE. Three latter are the vessels that have been tried out by the Marine Oil Engine Trials Committee in Great Britain, and the information given by Mr. Baker provides the naval architect with a means of analyzing how predicted figures compare with actual ship performances. In the case of the tanker WELLFIELD the trials were of the standard character. In the case of the DOLIUS, SYCAMORE and PACIFIC TRADER thrust meters were used, enabling additional data to be obtained, and the DOLIUS and SYCAMORE were furthermore fitted with torsionmeters. No judgment is passed on the discrepancies of power measurements shown in the DOLIUS trials, but the comment is offered that the torsionmeter figures accord better with the model data. Again in the SYCAMORE trials the same comment is made. This accords with the criticism we made of the indicator rig in our review of those reports (MOTORSHIP, May 1925, p. 379). Mr. Baker sums up that the N.P.L. method of obtaining the quasi-propulsive coefficient from the models is justified, predicted thrusts are generally lower than actual thrusts, the comparison of $\frac{T}{V_2}$ to a $\frac{V}{PN}$ base obtained in ship and model is reasonably good in the single screw ships but unreliable in the twin screw ships, and power measurements are unreliable. Mr. Baker suggests that a torsionmeter or thrust meter be fitted in all ships and the indicators used only to indicate how the engine is working, but not as an absolute measure of power.

Star Contrapropeller

By Walter Pollock. Read before the N. E. Coast Institution of Engineers and Shipbuilders, Newcastle, Eng., Jan. 1926.

In a very instructive paper Mr. Pollock traces the steps in the development of the present design of Star contrapropeller, shows how the efficiency of the guide blade device was increased at each stage of development and concludes with examples of the recorded performances of vessels fitted with contrapropellers. Arthur Rigg in 1866 was the first to attempt to eliminate the loss due to rotation in the propeller stream. He used flat blades on the rudder post. Thornycroft in 1880 developed the device with curved blades, but lost his gain by shrouding the propeller and guide

blades. No further work was done until Brook Sayers experimented in 1912 with curved blades partially shrouding the propeller stream. Wagner in Germany was experimenting about the same time and later advised Brook Sayers to reduce his shrouding. Hass started in 1913. Then came the war. Success finally was won and demonstrated in the Hamburg experimental tank with the Star contrapropeller. Today a total of 160 vessels representing 600,000 tons and 200,000 hp. have already been fitted with the device. The m.s. MONTE OLIVIA (14,000 tons gross and 7000 s.hp) was built with it and the sister vessel MONTE SARMIENTO is now to have it added. A number of other motorvessels are fitted with it, and it is meeting with signs of favor from American owners.

Catalogs

Ochromite Valves—A 16-page bulletin giving the chemical and physical properties of, and instructions for machining, forging and welding, Ochromite. Ochrome Valve Co., Baltimore, Md.

Electric Heat in Industry—A 32-page illustrated catalog showing the applications of electrically heated furnaces for heat treating, hardening and melting metals for the engineering industries. General Electric Co., Schenectady, N. Y.

Fruit Ships—An 8-page illustrated catalog outlining the conditions of the fruit carrying trade and the development of the fruit carrying ship. Swan, Hunter & Wigham Richardson Ltd., Wallsend-on-Tyne, England.

Western Enterprise Diesel Engines—A 48-page catalog, bound in imitation leather, describing and illustrating the Western Enterprise Diesel engines, with condensed specifications of each type, dimension prints and pictures of boats. Western Machinery Co., Los Angeles, Cal.

G. E. Arc Welder Type W. D. 11.—A 4-page bulletin descriptive of a portable welding generator designed for service in shipyards, marine repair yards, general machine shops, etc. General Electric Co., Schenectady, N. Y.

Gas Engine Driven Arc Welding System—A 4-page bulletin describing an arc welding generator for use on board ships, repairing lighters, etc. General Electric Co., Schenectady, N. Y.

Messroom Maxims and Fables

NEVER heard of anyone getting hurt as the result of having the engine blocked so it can't move while men are working on it.

The greatest difference between getting a gasket cut with a hammer and getting a haircut with a hammer is that the barber could not get away with it.

That prompts us to remark that getting away with it is not the most important thing which anyone does.

No use condemning machinery if we do not understand it.

Keep all the safety valves working, but not blowing off.

A drop of oil in the bearing is worth two in the can.

No use *flogging the counter* on motorships. It is a thing of the past, like the aroma of the mulligan stews cooked on the coals before the furnace door.

Without knowing a thing about navigation some engineers think they could run the ship better than the skipper.

And on the other hand some skippers do not know as much about navigation as they think they know about mechanics.

With all the advantages which a motorship has over a steamship she can not burn up the deck houses and furniture to bring her home.

Consumption of fuel equals 7½ lb. coal or 15 lb. dry pine wood for each cubic foot of water evaporated, but what the deuce has that to do with motorships?

A loose nut on a bolt or an engineer is a bad thing to have in the engine room.

Log tables are handy in math', and log books in accidents.

It is not how much brains, but the way he uses what he has that makes the difference in a man.

Keep the exhaust gas steam generator at least partly filled with water most of the time.

No use to scour the commutator with sandpaper to stop a spark made by a loose brush holder.

Being an officer does not command a *sir* on all ships, but conducting yourself as one does.

Taking fuel tank soundings while the ship has a list is a whole lot like taking temperatures with a broken thermometer.

Don't forget to oil the engine room mechanical telegraph.

Some ships are rushed out of port before they are completely overhauled. However, it seems that no matter how long they remain in port there is always something more to be done.

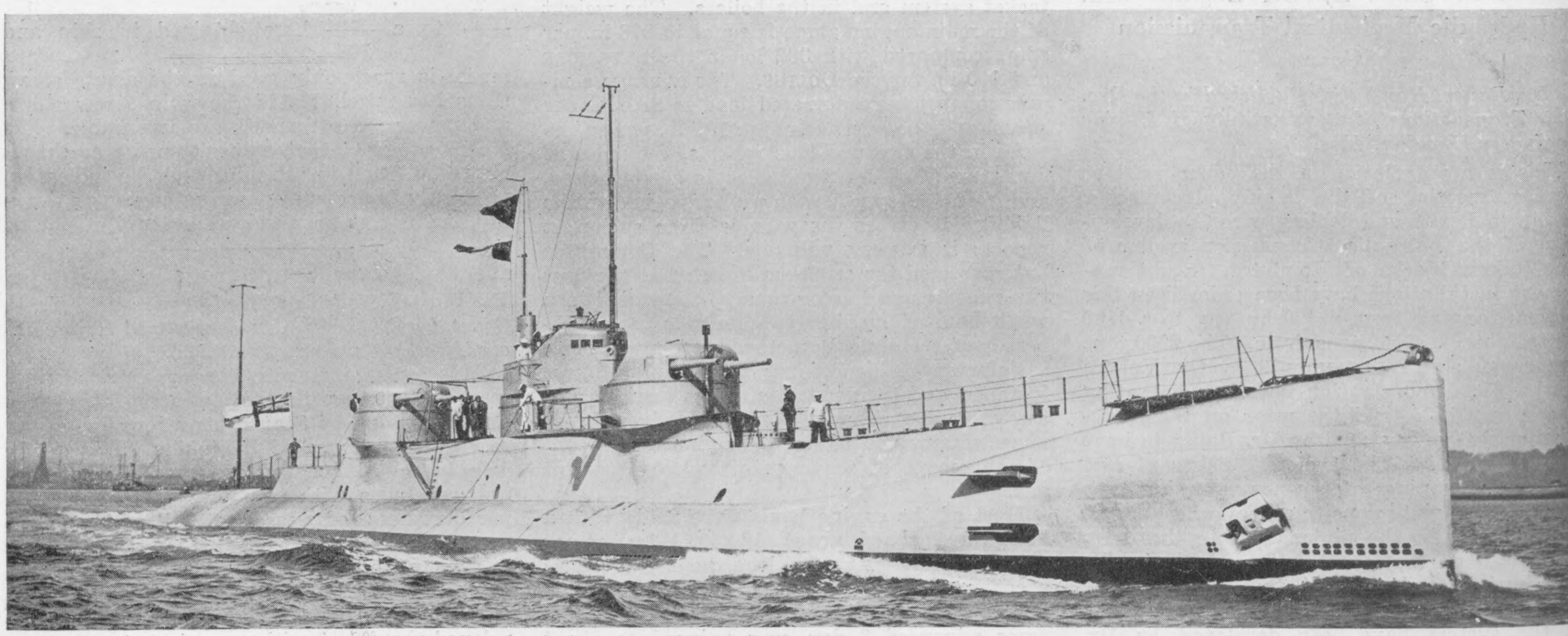
The cover of an instruction book makes a good gasket, but used as such it makes a poor instruction book.

An oil engine in starting said "Puff."
Quoth the engineer, "Now do your stuff."
For it wouldn't go round,
For it shortly was found
That of fuel there was scarcely enuf.

Said an engineer, Samuel McGee,
"From a steamship I've just been set free,
Motorships I have found
Sail the wide world around—
Their oil engines suit me to a tee."

An engineer with chisel and hammer,
Disdaining the use of a spanner,
Said, "This should do it no harm,
Since down on the farm
Nuts were cracked in a similar manner."

A. B. N.



British submarine X1, believed to be about 410 *ft. long,* 3500 *tons surface displacement,* 12,000 *hp. and* 22 *knots speed*